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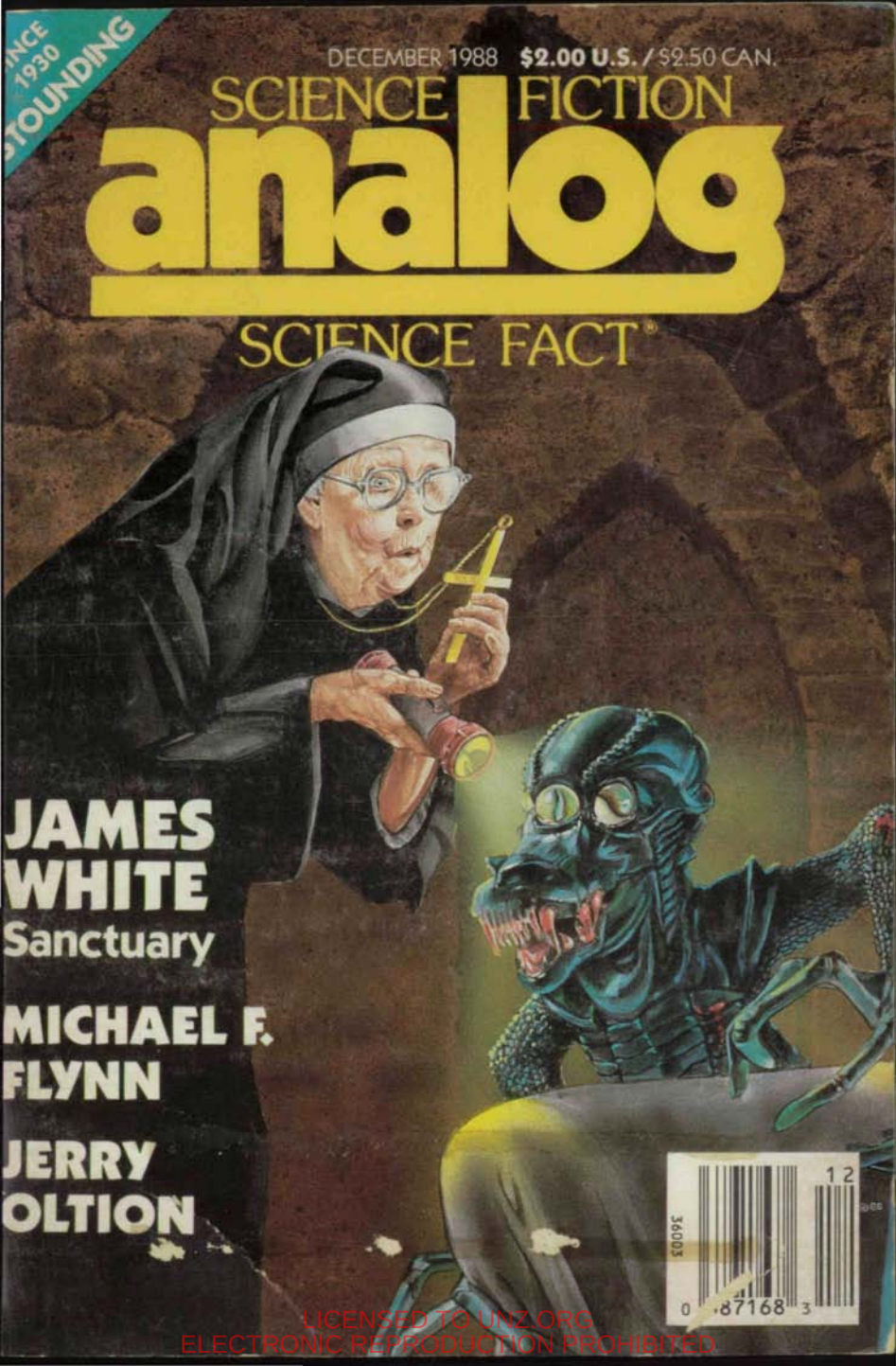

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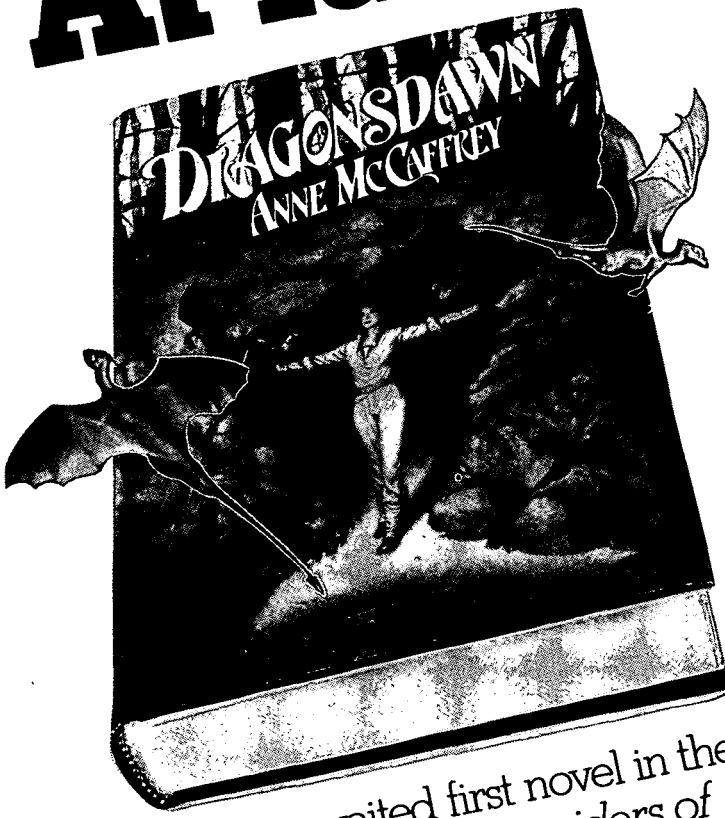

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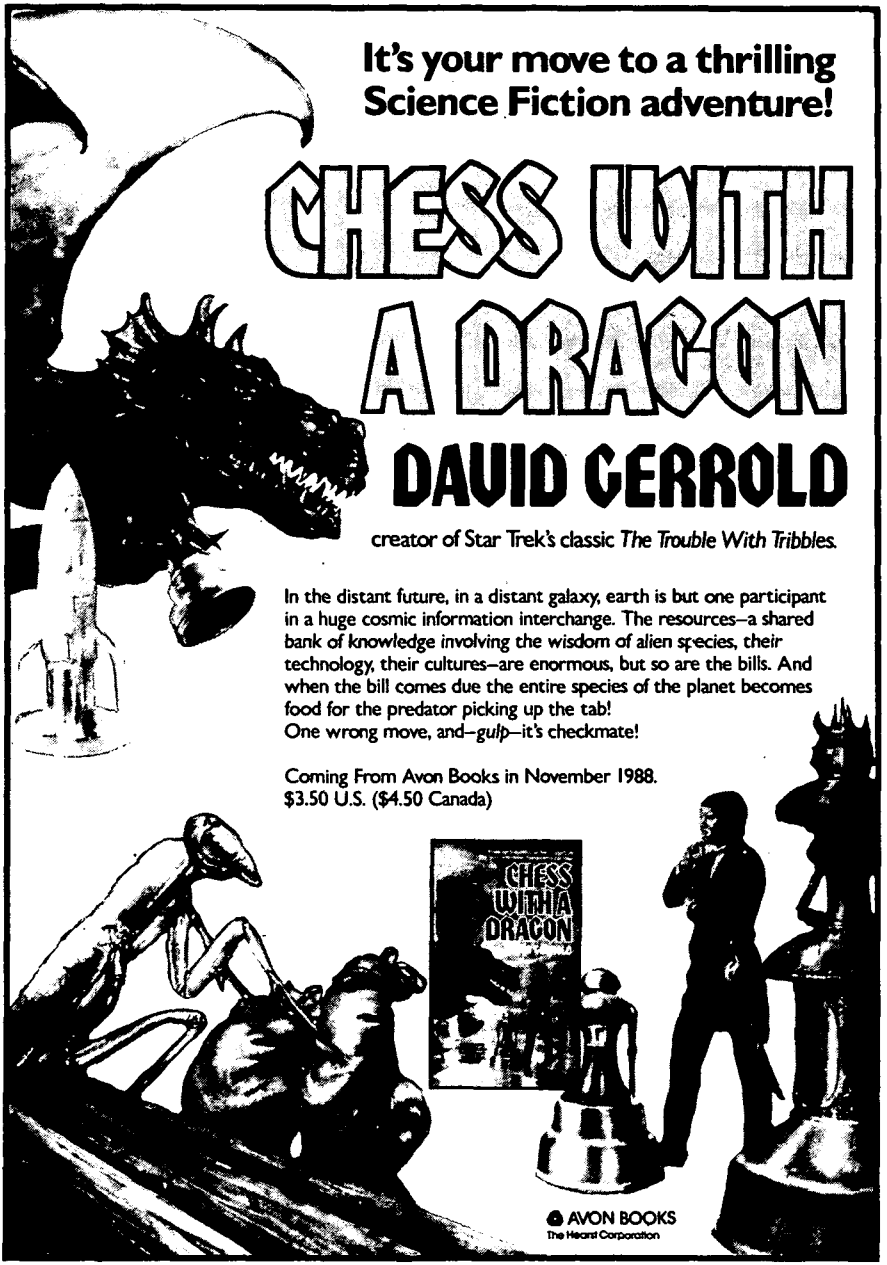

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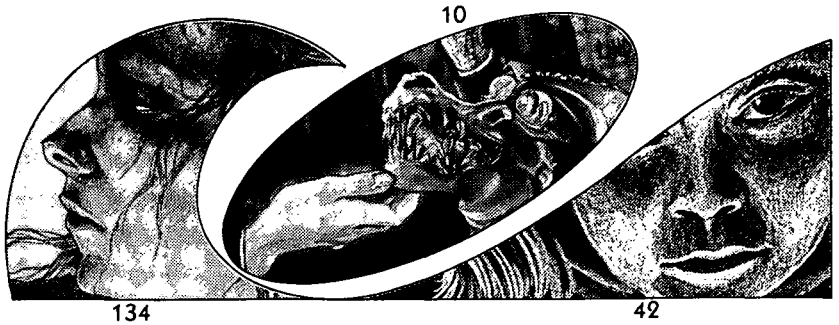

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Editorial

PROGRESS!

Stanley Schmidt

Back around the beginning of this year I mentioned the breakup of The Telephone Company into lots of little telephone companies, as a possible example of a case where a well-run monopoly might actually be preferable to an open market with lots of competitors. I cited the special circumstances attached to a system whose very reason for being was to *unify* a bunch of customers scattered all over the map, and had the audacity to suggest that it was not clear to me that the overall phone service I was getting *now* was better than what I was getting *then*. For this heresy I was duly raked over the coals by a number of readers who assured me that everything was *obviously* much better now. Incorrigible rascal than I am, I remained skeptical. I had to grant (as in fact I had done explicitly in the original editorial) that long distance rates had gone down, but I don't recall that anyone ever called my attention to any other clear advantage of the new regime—or directly addressed my assertion that "price isn't everything."

Well, I have seen the light. Those readers who were so disappointed with my earlier obtuseness may now welcome me into the fold. It has been brought to my attention that there's a whole aspect of this business of how to run a large, complicated network that I hadn't even given much thought to. My thoughts were directed to it earlier this week by a loud, steady but slightly buzzy hum that developed in my home phone and stuck around to accompany all subsequent conversations, dial tones, and whatnot.

The phone remained usable, but the hum was always annoying and sometimes made hearing very difficult. So I decided something had to be done. In the Bad Old Days, this would have been an absurdly simple matter of calling The

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Service Number given in the front of the directory for The Telephone Company, and waiting for somebody to track down and fix the trouble, wherever it might be, while I went on about my business. In this Brave New Era, things were a bit more interesting.

The source of such a noise can develop either in the telephone itself (which is leased from an outfit I'll call Company A, whose main business is long distance service) or in the wiring somewhere in or associated with my house and/or neighborhood (which is owned and maintained by Company B, which concerns itself only with the local network). Had an extra telephone, an extra jack, or certain test equipment been handy, it would have been easy enough to determine pretty definitely whether the trouble was in the phone or the lines. As it happened, those things were *not* handy, and in general it cannot and should not be assumed that most customers will have them available. Maintenance is, after all, one of the services Companies A and B are being paid for.

But which company should I contact first? I had to consult the phone book to find out what the new rules were, which in itself consumed the time that formerly would have been used to make the one call required for service. What I learned was that Company A will cheerfully exchange phones at any time and at no charge, and Company B will repair lines at no charge—but if Company B's repairmen find that they've been called out for a fault which lies in a telephone, they will bill you for the wasted visit.

This was progress: it clearly indicated that the cheapest way to find out where the trouble was was to go to the nearest Company A center, which I remembered was a mere four miles away, and bring home a new phone to try out. If it worked, fine; if not, it was time to call Company B. I checked the phone book to make sure Company A still had its nearby office, then pulled the phone off the wall and sallied thither to get a new one.

The office was still there, physically, but the only evidence of Company A was a sign in the door saying it was permanently closed and their nearest office was now at a location some twenty miles away—for which, mercifully, a phone number was given. I wasn't thrilled with the prospect of driving an additional twenty miles out and back, but if that was what I had to do, it was what I had to do. And since I was already out anyway, I might as well do it right away instead of wasting time going home first.

Having been stung once, I decided that before going it would be wise to call the number on the sign to make sure that the alleged temporary office really was still there, did what I needed it to do, and was going to be open when I got there. So I sought out a pay phone and dialed said number (which turned out to be in another zone and cost 40¢ for the first three minutes). The woman who answered did indeed identify herself as representing Company A, but said she could not exchange phones and

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didn't know who could, but would connect me with an operator who might be able to direct me somewhere appropriate.

After a lengthy pause I found myself connected, not to an operator, but to a recording informing me that the number I'd just dialed (which it repeated for clarity) was no longer a working number. This was interesting, since I'd just been talking to it. Evidently it had been disconnected in the last half minute or so (but the phone cheerfully ate my 40¢ nonetheless).

That being the case, I hung up and dialed "O." That did get me an operator, but of the wrong variety. She worked for Company B, and my business was with Company A. She eventually offered to connect me with a Company A operator, which was nice, and in fact managed to get a recording

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telling me that all Company A operators were busy, so would I please hold. I held for almost five minutes (the *phone company* doesn't have enough lines?!), during which time I was kept entertained by elevator music, occasional reminders that the lines were still busy, and a cold drizzle which started about then. (You've probably noticed that real phone *booths*, giving any shelter from the elements or any semblance of privacy or quiet, are very nearly a thing of the past in this country. Furthermore, this particular cubbyhole-on-the-wall was mounted at a height suitable for calling from a car, even though it was set a good fifteen feet back from the curb on a shopping center sidewalk—no doubt to keep callers from getting too comfortable and tying the phone up for too long. But all that is incidental to the issue at hand. . . .)

In good time, a genuine Company A operator actually came on, assured me that any suitable service center would be happy to exchange my phone, and gave me locations and phone numbers for two—both about twenty miles away, in opposite directions. (Figuring out how conveniently spaced they are is left as an exercise for the reader.) One of them, interestingly, was in the same location alleged by the original sign telling me the one near home had closed. That one was a bit closer than the other, and getting there and back at least didn't require any bridge tolls, so I called that one and was assured that I could come right in. I did; and to give credit where due, I must point out that I received very efficient, courteous service once I got there. I went home the proud possessor of a new (well, reconditioned, anyway) phone that didn't work any worse than the old one.

Unfortunately, it didn't work any better, either—so I still had to call Company B. But at least now I *knew* they needed to come, and all it cost me was a two-hour runaround and forty miles worth of gas and oil. Company B assured me they'd get somebody out here within a few days (and, again to give credit where credit is due, they did). And in the course of reaching this assurance, I'd got to go for a nice ride and visit some new places, instead of just sitting at home getting my work done.

Isn't that a lot more interesting and fun than just making one little boring call and waiting for the repairman to come? How could I ever have doubted?

Now, for our next trick, maybe we can reorganize the car repair business so that you have to go to a different shop for every part of the car. True, you may occasionally get stuck with an extra bill if you guess wrong about where the trouble is, but surely that's a small price to pay for the sheer entertainment value of such a system! ■

●Most people want security in this world, not liberty.

H.L. Mencken

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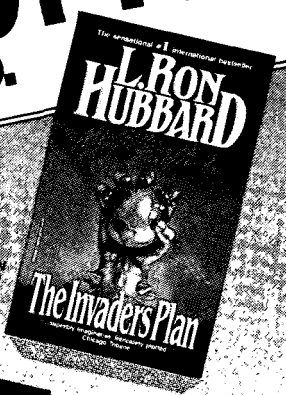
ONCE IT'S GOT YOU
IT WON'T LET YOU GO.



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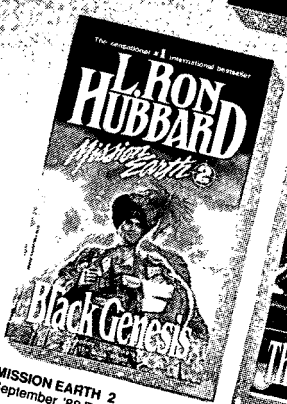

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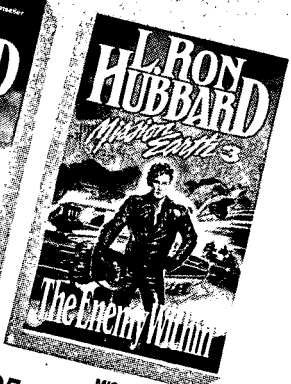

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SANCTUARY

James White

There have been many guesses
about where on earth extraterrestrials
would go, and who should deal with them.
There's one very old group of humans
with appropriate experience—and
it's *not* the one most often suggested.

Ron Lindahn and Val Lakey Lindahn

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The convent of the Sisters for the Missions to Africa was housed in a one-time castle on a low promontory which threw aside the long, North Atlantic rollers like the bows of some great, basalt ship and gave to those who dwelt there, in whatever direction they chose to look, a view of scenery of such wild and extravagant beauty that it was almost in questionable taste. This scenic grandeur was the principal reason why the establishment had been designated as a Rest House, a place to which were invited the sisters of many different missionaries, nursing and teaching orders for the purposes of rest, spiritual recuperation, the furtherance of their studies with minimum distraction, or simply to live out the remainder of their days amid surroundings of great beauty, solitude and peace.

But on this occasion the visitor had arrived uninvited and, as a result, the peace and solitude had departed. Now the crumbling outer wall was being besieged on the landward side by the squadron of tanks, with an infantry unit and an observation helicopter in support and the low, grey shape of a guided missile destroyer lay close offshore. Within the walls a TV outside broadcast van and trailer were drawn up by the main entrance, and the general untidiness had invaded Sister Augustine's study, whose polished wood-block floor was littered with power lines for the portable lights and cameras.

There were four program participants, the presenter, Mr. Matlock had told her with one of his large, insincere smiles. Sister Constance and herself would be on the side of the angels, and the other two were Doctor Watterson, a social psychologist, and Captain McCloskey, whom she had already met, representing the military interest.

Perhaps out of deference to her age and position as sister-in-charge of the convent, she had been seated first and kept so busy with the lighting and sound adjustments occasioned by her dark habit and soft voice that there had been no time to speak to them, or even to ask the advice of Sister Constance who was sitting like an enormous, black-garbed Buddha beside her. But if this had been done deliberately in an attempt to unsettle her before the innquisition to come, then it was a minor additional worry compared with the news one of the sisters had whispered to her as she had entered the room, and so she decided to remain silent.

It wasn't cowardice, Sister Augustine told herself as the fanfare which opened the program sounded quietly from a speaker and the opening titles rolled up the monitor screen; it was just that she knew of no right time to drop a bombshell.

"This is Ben Matlock," said the presenter into the camera, "welcoming you to another Trial by Television program, a series which investigates, interrogates and fearlessly proclaims the truth regarding those among us who hold themselves above the law. It is a very special trial we are conducting here today, not only because the program is open-ended and will go on for as long as it takes instead of the usual fifty minutes, or because it is considered important enough to go out live by satellite to countries all over the world. It is because the person on trial is one that the vast majority of our viewers, and certainly I myself,

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would normally consider blameless and with nothing to hide.

"This person," he went on grimly, "is not one of your legal, in quotes, criminals against whom the law is powerless, or a cynical and self-seeking politician, or even a religious zealot intent on leading her followers back into the dark ages, although some of you might give me an argument about the latter. She is, in fact, a nun who has been practicing the religious life for close to half a century. But she most definitely has something to hide.

"By now we all have a good idea what it is," he continued. "However, it is also my intention to find out the reason for her continuing to hide it in spite of numerous requests, and even direct orders, from the highest civil, military and ecclesiastical authorities, to give it up. Could it be that this is just a selfish and cynical attempt to capitalize on the situation? This is a fine, picturesque setting for the convent she runs but, I have discovered, the place is badly in need of structural repairs and replacement of outdated amenities, and the fees which will accrue for a world-networked program like this will be considerable.

"But in this particular program," he went on smoothly as Sister Augustine opened her mouth to protest, "we are not dealing with a person who has raised lying and misdirection to major art forms, but the ageing and much-respected sister-in-charge of this religious establishment. It could well be that the situation is no more complicated than that of the person who has grown old in authority and, perhaps, too set in her ways to relinquish it—"

"Sister Augustine is neither senile nor a martinet," Sister Constance said in her deep, baritone growl, "and if you're suggesting anything so silly—"

"Please, Sister," Matlock broke in, holding up a hand. "You will both have ample opportunity to speak, later. Right now we should begin at the point where things began going wrong for you, with the first visit of Captain McCloskey. Will you tell us what happened, Captain?"

Without looking at anyone in particular, the officer described his first meeting with Sister Augustine and several other nuns she had introduced as her counsellors. The sister-in-charge had refused permission to let his men search the premises and, without giving any specific information, he had suggested that the object of their search was a hungry and potentially highly dangerous escapee from the nearby wild-life park. He had not expected to find anything, but the convent was the only sizeable structure in the area that had not been cleared and it had to be eliminated as quickly as possible before the search could be extended.

He went on briskly, "While I was trying to frighten, or at least worry them into giving the required permission, one of the sisters present, a very elderly nun who had seemed to be asleep until then, told me that I was being silly because the poor thing was in no condition to hurt anyone. Realizing that I now knew the creature was on the premises, Sister Augustine gave me one of the photographs she had taken when it had first arrived. In the hope that she would hand over the creature, I decided to give Sister Augustine all the information, which

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at that time was NATO restricted, then in my possession."

"What did you tell her, exactly," asked Matlock, "and did she appear to understand the implications?"

"She understood well enough to debate them in detail, later," said Captain McCloskey. "I told her that eight days earlier our missile surveillance radar had picked up the trace of an unidentified object falling or diving towards the surface at a speed in excess of any current aircraft capability. The path of the object was erratic, suggesting that it had on-board guidance and was taking deliberate evasive action, perhaps against an expected military attack, and for the last few moments of flight it had been sea-skimming and invisible to our radar. For that reason we had been unable to say exactly where it had crashed or landed except that it was within a one hundred and fifty miles diameter circle which enclosed the most southerly of the Western Isles of Scotland and this stretch of the North Irish coast. At no time was it observed directly, although the radar trace suggested the mass of a medium-sized airliner, and we had no idea of the invaders' capabilities."

"The *survivors'* capabilities," said Sister Augustine gently.

"Or the survivors' weapons capability," the captain went on, nodding politely towards her. "And I explained that the vessel had originated outside this solar system and for that reason possessed an interstellar flight capability and a level of technology far beyond our own. I said that its erratic flight-path could be equally attributed to a forced landing by a civilian vessel or a mishap suffered during a military reconnaissance mission, but either way the crash might give us the only advantage we were likely to have against their advanced technology, and enable us to neutralize and possibly capture them. I also asked the sister if the creature she had was carrying anything like a weapon."

He hesitated for a moment, looking at Sister Augustine, who said quietly, "I told Captain McCloskey that when we found it, it was wearing neither clothing nor equipment."

"Please go on, Captain," said Matlock.

"I told her," the officer resumed, "that its level of intelligence, and more importantly, its intentions towards us were unknown. That it was possible it considered us a lower order of life, of as little consequence as vermin, and that the only way to find out for sure was by interrogation, long-term behavioral observation, physical and psychological testing, and whatever other action was deemed necessary, while it was kept in confinement under close restraint. I told her that the responsibility for initiating this process was mine, and that I would relieve her of the creature as soon as she showed me where it was hiding so that I could bring in some men and a couple of armored personnel carriers to take it away.

"She said no."

"Surely she said more than that," said Matlock drily as the monitor showed her face in close-up. "And I want to hear it from you, Captain. Sister Augustine will have her chance to speak later."

Looking uncomfortable, the officer cleared his throat and went on. "She

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told me that all of the sisters had already visited the creature, that in her opinion it was not a threat to anyone, and that I, too, would be similarly convinced of that if I were to meet it. But she said that she could not allow that because I was armed and might feel impelled to capture it single-handed or, having discovered its location, lead my men on a raid to capture it. She said that if I was to violate the cloisters in that fashion, or threaten such action, then I and my superiors would be seriously criticized by the members of a great many religious denominations, as well as by the media at home and abroad, and that I should carefully consider the career implications."

"So she was trying to blackmail you," said Matlock, giving a knowing look into the camera. "What else did she say?"

"I was trying to *advise* the young man," said Sister Augustine sharply. "And I see no sense in having Captain McCloskey speak my words when the original speaker is present, nor do I think that you have the moral or ecclesiastical authority to impose a vow of silence on me at will, so I shall say to you exactly what I said to him."

For a moment she strove for inner calm and outward composure, then said quietly, "My own perhaps oversimplified view of this situation is that the creature is a stranger from a far land, and the proper action towards it is specified in a book of regulations with which you must be familiar. The creature is alone, frightened, injured, possibly grieving the loss of friends, and is being hunted like an animal. The hunters are armed and afraid or at least highly nervous of it, so that it risks more serious injury or death at their hands.

"Although it cannot ask for help in so many words," she continued, "the request is implicit in the situation and our protection will be extended to it. So the creature will not leave this house until it indicates in some fashion that it wishes to do so. During its stay here it will not be molested in any way, nor will it or our sisters be approached by outsiders without permission or prior invitation. This includes you, young man, your subordinates, superiors and anyone else who tries to contact it.

"I am invoking the rule of sanctuary."

For a moment there was absolute silence in the room, broken by a short and rather forced laugh from the presenter.

Still smiling, Matlock said, "Come, come, Sister. Let's be realistic. You are still living in the middle ages with this sanctuary business. Suppose the captain had gone back to the same period and invoked the rule of trial by combat? What would you have said then? Told him, as I am telling you now, that the rule is out-dated and ridiculous?"

Speaking for the first time, Dr. Watterson said, "A form of Sanctuary is sometimes given by foreign embassies to native political or religious leaders who—"

He broke off because Sister Constance was rising ponderously to her feet.

"Threats of using conventional military force have already been made without results," she growled, and her large, round face was split briefly by a smile. "If I remember my history correctly, in a challenge to trial by combat

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it is the challenged individual, or his or her champion, who has choice of weapons. I have never used a weapon of any kind in my life. But if the information is of any use to you, when I went home last Christmas I was still able to beat my big brother, at arm wrestling."

Captain McCloskey stared up at the vast bulk of the sister for a moment, then turned to Matlock. "If I was to arm wrestle a nun for possession of an extraterrestrial, or for any other reason, I could kiss my hopes of further promotion good-bye.

"Especially," he added gravely, "if she won."

It was several seconds before Matlock could make himself heard, then he said irritably, "this is not a laughing matter, Captain. . . ."

"You started it," said the officer.

". . . After the sister invoked her rule of sanctuary," Matlock went on, "what did you do then?"

"For about fifteen minutes I tried to reason with her," the captain replied. His face reddened slightly as he added, "But there are situations, Mr. Matlock, where one knows instinctively who has the rank. I left."

Without giving anyone else a chance to respond, the presenter said quickly, "Sister Constance, you seem very anxious to join this discussion, and you were the first person to see the creature. Please tell us as much as you can remember about it. In your own words, in your own time."

"It is ancient history I have trouble remembering," said Sister Constance. She showed her irritation by exhaling not too silently through her nose, then went on calmly, "I was getting the vegetables for that day's lunch from our cold store, a small cellar without lighting or power which is entered by an external door in the orchard-facing wall of the castle, when I heard a noise coming from the lower cellar. This is a larger and even colder room than the cold store, used principally to store junk, and is rarely visited by the sisters because they believe that it was once the castle's dungeon and torture chamber. I took one of the candles I was using and went down the steps to the lower cellar and followed the sound, a sort of low, bubbling noise, until I found out what was making it. The candle wasn't bright enough to show the creature clearly, but I was pretty sure that I hadn't seen anything like it before. I ran, well no, considering my weight I left quickly to tell Sister Augustine about it."

"And then?" asked Matlock.

Sister Augustine said quietly, "I went with sister to the cold store, bringing an electric torch, and quickly established that the creature was injured, fully conscious, intelligent, had a strong aversion to the heat of a candle flame but not the light from my torch, and that it had not originated on Earth. We treated the injuries, which were mostly superficial, and Sister Constance gave it a selection of food to—"

"Really, Sister, this is utterly ridiculous!" the psychologist opposite her broke in. A camera swung to cover him and the monitor briefly displayed his angry expression above a caption saying that he was Doctor Kenneth Watterson, a lecturer in psychology at the university, before dissolving into the still picture she had taken of the bandaged alien. He went on, "are you telling us that you

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saw, quickly identified and treated the injuries of a hitherto unknown form of life, just like that? Look at it, for pity's sake. It looks like an over-bandaged volunteer casualty of a first aid demonstration! Sister, that was thoughtless, even stupid in the circumstances. You could have been, you may still be, responsible for killing it. You had no right to act in such an irresponsible fashion. You aren't qualified in this area."

"Are you?" asked Sister Augustine quietly.

The psychologist shook his head impatiently. "I am also a doctor of medicine, and what worries me is that food was given to a being without any regard to possible toxic effects on its metabolism, or for the possibility of a two-way paassage of mùtually harmful pathogens for which neither the creature nor those, er, tending it have any immunity. Acting as she did was, was certainly beyond the level of competence of a simple convent cook!"

"You are assuming, Doctor," said Sister Augustine sharply, "that because Sister Constance is very large that she is also very stupid. That is not so. She is the cook until this weekend, when another sister will take over the duty. She likes cooking, is good at it, and the others prefer her cooking with the result that she is often prevailed upon to cook more often than the duty roster requires—"

"With respect, Sister," Matlock broke in, "we aren't terribly interested in your catering arrangements."

". . . But her reason for being here," Sister Augustine went on, ignoring the interruption, "is to complete her thesis for an MSc that will improve her chances of being appointed principal of the Dominican College in the city when the present incumbent retires next year. The degree doesn't qualify her to act in this situation, it is her simple common sense that has done that."

Captain McCloskey was rubbing the side of his face, with the hand concealing his lips. The features of Watterson remained stiff with anger.

"Then please tell us, Sister," said Matlock, "what exactly you did to this creature?"

"On the subject of my own qualifications," Sister Augustine went on firmly, temporarily ignoring the question, "I belong to an order of missionary sisters who are required to take advanced nursing training, and in this capacity I have worked in Africa for nearly twenty years. At the risk of being thought boastful, I have learned enough about the human anatomy to know with certainty when a being isn't human, and have accumulated enough practical experience in the treatment of the sick and injured, often in isolated areas where the indicated medication is limited or non-existent, to at least try to help a case where our human medication was inapplicable and perhaps lethal to the patient's non-human metabolism."

The monitor was showing her color photograph again as she went on quickly to describe how Sister Constance and herself had communicated with the creature by doing a number of simple sums of addition on their fingers, and their wonderment when the creature demonstrated its possession of intelligence by responding at once, even though the arm injuries must have made it painful to do so. Then she described the first

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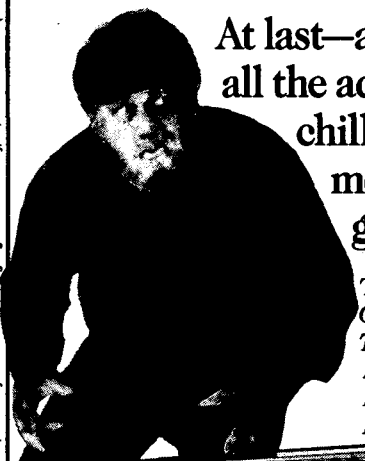
© Universal Pictures, Courtesy of MCA Publishing Rights. Lon Chaney, Jr., in *The Wolfman* (1940).



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physical contact while she had been examining one of its wounds.

"The creature seemed very reluctant to let me touch it, at first," she continued, pointing towards the picture on the monitor. "To understand why, I will have to describe its condition as we first saw it. . . ."

The creature had been curled up behind a large, dilapidated divan. It was large, measuring about eight feet from its heavy, blunt head to the tip of its armored tail, and slightly resembled a black alligator with iridescent scales. It had three pairs of limbs. The pair mounted below the base of the neck were thinner than the others and terminated in six digits that had far too many joints, and the remaining four, which supported the lower body, were shorter and thicker and ended as flat, round feet with long, webbed toes.

The creature's eyes, three of them, were very large, recessed and protected by bony ridges and spaced equally around the head. Its other facial features were a wide mouth with very large teeth, which appeared at first to be stained with blood but on closer examination turned out to be painted in different colors, and a number of orifices surrounded by wrinkles and folds of skin which were thought to be ears or nostrils. There were two long, vertical flaps of skin, from which came the bubbling sounds, situated midway along the thick, tapering neck.

The body was marked in several places, particularly at the limb joints and other areas where the bones came closest to the skin, by lines and patches of red and brown characteristic of the fresh and dried bloodstains usually associated with incised and abraded wounds.

". . . When the torch was brought closer to inspect one of the larger incisions," Sister Augustine continued, "the creature didn't move at first, then suddenly it swung its tail at me."

The recollection made her pause for a moment, then she went on, "That tail, which you can see is curved backwards and lying along its spine, is long and thick and terminates in a flat, boney plate that has very sharp edges, and must be its principal natural weapon. The creature swung it at me, but checked the movement when the edge of the bony blade was a few inches from my face."

"Weren't you afraid?" asked Matlock.

Sister Augustine paused just long enough to indicate that it had been an unnecessary question, then went on, "When I approached it a second time, it remained passive and allowed me to touch the wound. It seemed clear to me that its earlier action had been meant to warn me to be careful, or at least gentle, during treatment. I think it communicated the idea very well."

She smiled at the presenter and went on, "We couldn't risk using any of the dressings or antibiotics from our medicine chest, for the reasons Doctor Watterson and I have already explained, so that the only safe treatment was irrigation of the wounds with water. In Africa we would have had to boil it first, but the supply here is natural spring water and, in any case, from the condition of the cellar floor, it looked as though it had been in the sea for a lengthy period without apparent ill effects. The clean-

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ing was necessary because its wounds had almost certainly been sustained by contact with the rocks below us, and it had subsequently crawled to the cellar. The incised wounds were cleaned, without using any possibly toxic soap, and the edges held together with folded pads made from bed-linen and firm bandages to aid healing. The abrasions were left uncovered because the blood in these areas was already beginning to congeal and form scabs. We made it as comfortable as possible on the old divan which, as you can see, was first covered with white sheets so that dust from the upholstery would be less likely to find its way onto the uncovered abrasions. Behind the divan we placed a covered receptacle to receive body wastes. . . ."

Doctor Watterson opened his mouth to speak and she went on quickly, "Naturally, the disposal of these wastes caused me some concern. The creature, who wore no protective clothing or, indeed, clothing of any kind, did not act as if it was worried about catching anything from us during physical contact, so I took comfort in the thought that the opposite was also true. But on Earth body wastes are a major source of infection, so we decided that the material should be buried, for safety as well as retaining it for possible future analysis, rather than risk spreading any possible infection by flushing it away in the usual fashion. The quantity so far has not been large, but the fact that our food is being metabolized is reassuring."

Watterson's manner was much less hostile as he said, "I think you acted sensibly in what was a most unusual medical situation, but allowing your cook to give it Earth food . . . That was not the time for offering simple, thoughtless hospitality, no matter how well meant. You could have killed it, Sister. You might still do so if there are cumulative toxic effects."

"It was neither simple nor thoughtless, Doctor," said Sister Constance in an irritated growl. "That picture shows the creature lying on its divan, so you can only see the edge of the coffee table in front of it. Sister Augustine and I put a lot of careful thought into the selection and preparation of that food."

Watterson looked skeptical but remained silent. Matlock said, "Don't keep us in suspense, Sister."

Once again Sister Constance exhaled through her nose, then said, "We decided that, even though the creature breathed our air and had red blood, its dietary requirements would certainly be different to ours, but that it would need food and water to aid its recovery. We decided that the only course was to offer it a choice of food and trust that its sense of taste and smell would enable it to select for itself items that were harmless, or least harmful. We already knew that it was unafraid of light but had a very strong aversion to the heat from a candle flame, so anything like a hot meal was out."

She smiled suddenly and went on, "The menu offered comprised a selection of raw and very thoroughly washed vegetables, cut up into pieces convenient for eating and with a single, whole vegetable on each plate to give the creature a clearer idea of what was being offered. There were also plates containing slices of meat, whole-meal bread, dry, uncooked and unmilked cereals, and small glass jugs of water and milk.

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Sister Augustine suggested that, the creature being an amphibian, it might like to eat fish. We tried it with some sardines, but washed them thoroughly so as to remove the tomato sauce and additives which might have confused its taste buds. The food was displayed on a long, low coffee table, also covered with a white sheet, within easy reach. We placed spoons or forks beside each dish, but no knives."

"With what result?" Doctor Watterson asked quickly, curiosity overcoming his earlier hostility.

"It didn't take any of the raw vegetables," replied Sister Constance, "or the milk or meat, but small amounts of whole-meal bread and the fish were acceptable. It ignored all of the cereals except for the bowl of oatmeal, which it emptied completely. It drank all the water, probably to help it wash down the dry oatmeal, which is why we've started cooking it and serving it cold to make it more palatable. We try it with other items, and any dish that is untouched for a full day is withdrawn, so it is dictating its own diet and eating, although perhaps not enjoying, our food. Most of the bandages have been removed, the wounds are dry and healing nicely, and it is able to move freely about the cellars.

"But sardines and cold porridge," she ended in an aggrieved tone. "That certainly isn't the kind of fare we normally offer visitors."

Matlock allowed himself the thinnest of smiles, but before he could speak Sister Augustine said, "Between the times of checking on its wounds and replenishing the preferred food, and during the night, of course, we leave the visitor unattended. Although all of the sisters have seen it by now, most of them are still a little nervous in its company. To give it something to think about, apart from its wounds and its future, and in the hope of improving communications beyond the present level of sign language and felt pen sketches, I moved in my portable TV. It is connected to the convent's power with the extension cable from our electric lawnmower, which enables me to switch off when the channel is running programs that are unsuitable."

"Censorship, Sister?" said Matlock drily.

"No, selection," she replied firmly. "It is shown natural history, geography and current affairs programs, but I thought that animated cartoons would only confuse it. And war films, which it could not know were fiction, would be frightening. It is able to see enough violence on the news broadcasts."

Suddenly, Doctor Watterson was smiling and nodding approval. He said, "you have acted much more intelligently and responsibly than I expected, both of you. I'm sorry, Sisters, I've seriously misjudged you."

Matlock, who seemed anxious that the protagonists not become too friendly, said quickly, "But the fact still remains that you are not properly equipped to cope with this situation. You *know* that you should have handed the creature over to those better qualified to do so instead of deliberately keeping its presence a secret. Sister, if it hadn't been for the alertness of Captain McCloskey, we still wouldn't know that it was here. Isn't that so, Captain?"

"I suppose so," said the officer,

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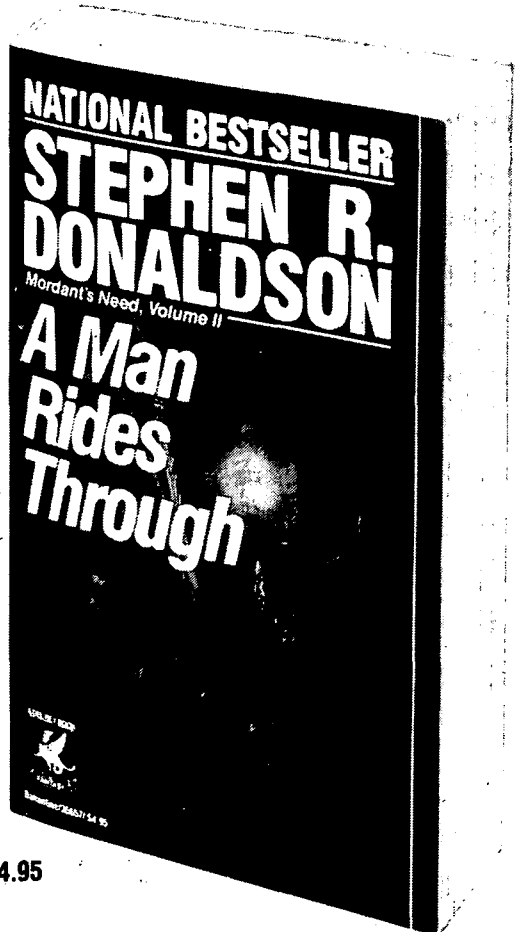

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looking very uncomfortable. "But I really blame myself for not being able to talk the sister into releasing it to me. I must have made a very bad impression."

"Not at all, young man," said Sister Augustine. "I'm sorry if I allowed my irritation to show. It was simply that you carried a weapon, something you should not do in a place like this, and were wearing battle dress and hob-nailed boots which were scratching the surface of our centuries-old polished floor. There was also the possibility, already mentioned, that you might take the visitor by force. But your manners were at all times impeccable."

"Thank you," said the captain, looking even more uncomfortable.

She went on, "That was one of the reasons why, during your second visit, I let you accompany the cameraman to film the creature. You weren't carrying a machine-gun and had changed into that rather smart day uniform with proper shoes. Another reason was that I wanted you to see the visitor then, in the hope that you would realize, and perhaps convince your superiors, that it was not an enemy."

Before the officer could reply, Matlock said irritably, "Come, come, Sister. Captain McCloskey is a professional soldier. He would not be misguided regarding the strength of an enemy from meeting an unarmed and injured prisoner. You're being totally unrealistic and stupid over this sanctuary business. Think about it. We have here the completely incredible situation in which you, an ageing sister-in-charge of this not very important religious establishment, have forbidden access, except to Captain McCloskey and a cameraman, to the first known extraterrestrial to visit Earth. You have done this in spite of continuing and increasing pressure from the military, civil, and through them your own ecclesiastical authorities. I know for a fact that your Sister-General and Sister-Provincial, your bishop and even the Papal Nuncio's office have all been asked to intervene, and have strongly advised you to release this creature to us.

"Sister, isn't there also a rule of obedience?"

"There is," Sister Augustine replied, choosing her words carefully. "But I have the responsibility here, and while one must obey lawful commands, one does not have to take advice, no matter from whom it comes or how strongly it is worded. Unless I were to be declared incompetent or mentally unfit, there is nothing more my superiors can do. This is a matter for my own conscience, which is, to the best of my knowledge, clear."

"I have a niggling doubt about that, Sister," said Matlock in a tone that sounded politely incredulous. "Normally my program investigates people who have much to hide and whose consciences are murky indeed. I don't think you would lie to me, but I have a strong suspicion that you aren't telling everything you know. Towards a member of a religious order there are, regrettably, constraints of language and behavoir which—"

"Mr. Matlock," Sister Augustine broke in gently. "I have watched and enjoyed your program many times, and I have no objection to your usual methods of questioning. The fact that none

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of your program subjects has ever been proven innocent does worry me a little, but if you have niggling doubts please let me try to resolve them. I'm sure that your language and behavior will not make me blush."

It was Matlock whose face was red. Ignoring the compliment, he said harshly, "Sister, why did you allow only Captain McCloskey and one cameraman to film the creature, instead of the usual team? Why were you so anxious that we film only the creature on the divan and its food table? And why was it that the footage we did shoot was precisely what was needed to ensure that you, ostensibly a simple, elderly nun, are able to hold us all to ransom? Did you realize that by so doing you would force us to come here, to screen this special program from a convent that is so obviously in need of major structural repair?

"Could it be," he went on quickly, "that the arrival of the creature was, from your viewpoint, a heaven-sent opportunity to effect those repairs? Is this whole sanctuary business simply a means of gaining maximum publicity? But did you, being simple and unworldly as you are, underestimate the broadcast and repeat fees that would accrue for a program that is being taken by virtually every network on the planet? Well, Sister, I can't estimate it either, because such a thing hasn't happened since the first moon landing. But I can tell you that it would be more than enough to repair the crumbling outer walls, and replace your antiquated central heating, and enough even to move your convent, stone by stone, and rebuild it anywhere on Earth that you chose, and with money to spare.

"We're waiting for answers, Sister."

"Then maybe you'll wait a moment longer," said Sister Augustine, "while I try to remember all the questions, including those you tried to answer for me."

"Take your time," said Matlock. "I'll remind you of any you've forgotten."

"Thank you," said Sister Augustine. For a moment she debated with herself whether it was a mortal or venial sin to volunteer incomplete information, then went on quietly, "The reason why only one cameraman, with the captain to help with the mike and lights, was allowed to film was that I thought the creature might have been panicked by a larger number of people into making some defensive act, especially since they would be using equipment which it could have mistaken for weapons. The creature has never met large numbers of human beings. The sisters visited it only two or three at a time, and it is quite possible that it thinks there are only a few of us. Nuns wearing habits tend to look the same even to Earthpeople."

Captain McCloskey laughed and Matlock frowned at him. She continued, "Another and more venial reason for restricting the filming is that the cellar is full of dusty old furniture and junk and is badly in need of spring-cleaning. I would have been mortified if you'd turned your lights on it. May I, too, express my feelings freely?"

"Please do," said Matlock.

"Very well," said Sister Augustine. "I dislike, and totally reject, your inference that I am some kind of religious, publicity-hungry and money-grubbing

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charlatan. I am very pleased that this program will earn us lots of money, but that money will be at the disposition of the sister-general of my order, not me. I have no doubt that most of it will go for famine relief and to our schools and medical missions, which are in very deprived areas, so that my central heating will have a very low order of priority. As for the idea that our convent could be moved brick by brick, just look at that . . ."

She raised her arm slowly to point through the study window, where the sun was dying a spectacular death beyond a glittering, amber sea and the dark, dramatic outlines of the cliffs. One of the cameras swiveled to follow the direction of her pointing finger.

". . . I cannot think of anywhere else I'd rather live."

"Sister," said Matlock drily, "are you trying to direct this program as well as star in it? Don't answer that. We'll run the film now and, believe me, the questions that follow will not be rhetorical."

All eyes were on the monitor as the shoulder-held camera tracked down the steps leading to the cold store, across the floor and into the lower cellar. There the light and camera had been turned on Sister Augustine while she explained that this was necessary to let the creature know that the equipment was harmless. Then the camera swung to bear on the creature itself and moved slowly closer. They could see every physical detail, hear every low, bubbling, alien sound that it made. The camera moved into a close-up of the head, chest and shoulders. A long-fingered, alien hand came into view.

It made the sign of the cross.

"And that," said Matlock in a bitterly disparaging voice, "is the reason for the naval vessel in the bay, the tank regiment presently drawn up before your walls, the continuing low-level aerial surveillance and, ultimately, the reason for this program. Because that piece of film has been seen by everyone on this planet with access to a TV, and they are seriously concerned. Not everyone, of course, just the ordinary, simple, superstition-ridden people who still make up the majority of the world's population. They, many of whom are not even adherents of your particular faith, have exerted so much political pressure on their respective government representatives that no civil or military authority will risk the simple, direct expedient of just moving in and taking the creature away from you, for fear of the serious religious and political repercussions that would certainly follow.

"So it has fallen on me, Sister," he went on, "to reason with you. To convince you that you are wrong to keep this alien from us or, if that fails, to show my audience that your position is untenable, ridiculous, based on superstition rather than reason, so that few objections will be raised when we do move in and take the creature from you.

"If you agree to give it to us now," he added, "you would save yourself, and your convent, a whole lot of grief."

Sister Augustine remained silent for a long moment, then she said, "I can't."

"A predictable answer," said Matlock. He went on grimly, "if the only way of gaining access to this creature is by discrediting you, and the narrow-

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minded, out-dated and superstitious kind of thinking that is holding it here, then discredit you I will. But I ask you, Sister, try to think more broadly. The first extraterrestrial to visit Earth is in your convent and the first, or perhaps the second thing you do is try to convert it to your religion! How narrow-minded can you get?"

"Just one *minute*, young man!" said Sister Augustine, in a tone that was neither nun-like nor gentle. "I've already told you about the incident when the creature warned me to be careful with its wounds, although obviously not in sufficient detail. Threatening me with its tail was the first time it made anything like a hostile act. When that tail came within inches of my face, I jumped back and crossed myself instinctively because I thought it might be about to kill me. Since then, it crosses itself whenever anyone visits it, but plainly the action is one of simple mimicry. It probably thinks it's making a gesture of friendship or recognition. The idea that we are trying to convert it to our religion is ludicrous. Even if we wanted to, we can't communicate well enough to exchange philosophical or theological concepts. Next thing you'll say is that I baptized it while irrigating its wounds."

The deepening color of Matlock's face suggested that he might well have been about to say just that, but instead he said, "Then you can assure me, Sister, that there is no religious significance, no deep universal meaning, no supernatural revelation in the creature's action? And can you also assure our viewers all over the world, the people of many religious beliefs, Christian and otherwise, who are deeply troubled by the thought of an extraterrestrial creature making this sign, that they have nothing whatever to worry about?"

"Yes," said Sister Augustine promptly. "Yes to both questions." As a look of quiet triumph suffused Matlock's face, she went on. "But having said that, I must confess to feeling seriously troubled myself by this whole affair. I keep asking myself why, of all the places on Earth where it could have come ashore, did it have to be at this convent? No doubt you'll say that it had to come down somewhere, that the location was due to sheer chance, coincidence, or fate. But you will understand that, following the vocation I do, I must also include providence."

There was a sarcastic edge to Matlock's tone as he said, "You're wriggling, Sister. First you say that the creature's gesture and presence have no religious significance, then suggest that it has." He turned towards Sister Constance. "Perhaps you can give me a straight answer, Sister. Can you remember, if you are allowed to remember that is, any occasion when Sister Augustine performed religious acts or prayed over this creature?"

"My memory," said Sister Constance, anger lowering by an octave her already deep voice, "is very good, and not susceptible to outside influence. The only time that anything like a prayer was said was on the first evening, when we had our arms around the creature lifting it onto the divan. But it seemed to me that Sister wasn't so much praying as thinking aloud."

"What did she say," asked Matlock, "exactly?"

"Very quietly she said," Sister

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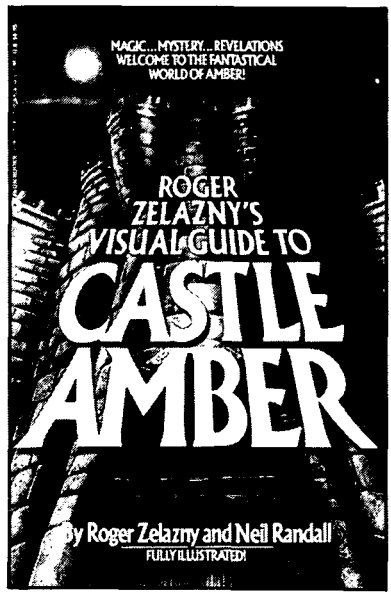

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Constance replied, "Dear God, your creation is much more complicated, and wonderful, than we thought."

At that moment the study door opened and one of the sisters, her identity hidden by the broad back of the sound engineer who was blocking her passage, tried to enter. Through the open door there also came, without impediment, the ineffably sweet and glorious sound of the Orbisfactor *Kyrie Eleison*.

"Your sacred music," said Matlock sarcastically, "is right on cue. But Sister, you promised me that there would be no interruptions."

"I'm sorry, Mr. Matlock," she said. "But you must understand that this is a convent and our religious exercises, including the singing of Vespers, must continue in spite of this influx of television people." She raised her voice slightly. "Please leave, Sister, and speak with me later."

The Gregorian plainchant was silenced by the closing door, and Matlock said, "I think Sister Augustine and I are beginning to irritate each other. Has anyone else a question?"

Dr. Watterson cleared his throat and said, "My interest in this is psychological rather than religious, Sister. You seem to have made friends with this creature, and now feel very protective towards it, even though it began by frightening you rather badly. I am considering the possibility that some kind of non-material influence, a form of telepathy perhaps, is being exerted.

"Also," he went on, "a little earlier you told us, and I hope I'm quoting you accurately, that threatening you with its tail was the first time it made anything like a hostile act. Were there other hostile acts? If so can you describe the circumstances and your feelings at the time, as fully as possible?"

"I wasn't aware of any mental influence, Doctor," Sister Augustine replied. "Making due allowance for the circumstances, my feelings were the same as those I would have towards any injured person requiring treatment. And if it was able to communicate telepathically, would we have such a difficult job making it understand us?"

Dr. Watterson nodded thoughtfully and waited for her to go on. She hesitated, feeling her face grow warm with expectation of the embarrassment so surely to come.

"Doctor," said Matlock eagerly, "I think you've entered a sensitive area."

Ignoring the presenter, she took a deep breath and went on, "The second and only other hostile act, when the creature gripped my wrist very tightly, happened when I tried to take away its property. This was a box which—"

"Sister!" Captain McCloskey broke in accusingly. "You gave me to understand that the creature had neither clothing nor equipment. You didn't tell me about any box. It might contain, or be, a weapon capable of unimaginable—"

She held up her hand and said, "I didn't know about the box until after your first visit, and decided not to tell anyone about it because of the kind of reaction that Captain McCloskey is displaying now."

Still concentrating all of her attention on the psychologist, she went on, "We discovered the creature holding it one morning, scratching and pressing at it with its fingers, and obviously trying to get it open. We brought it our tool kit,

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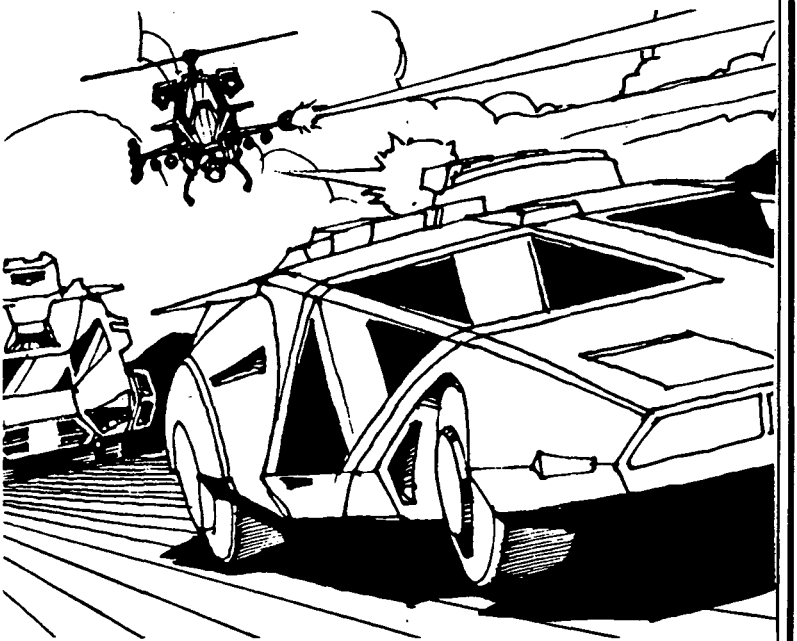

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the one we use for making electrical repairs, but that didn't help. After trying to open it for about half an hour, the creature threw the box into a corner. If you'd been there, Doctor, I think you would have agreed with me that, for an extraterrestrial, it showed a very human reaction towards a stupid gadget that wasn't working. When I picked up the box to see if I could open it, the creature grabbed my wrist tightly. When I let go, it put the box under the divan and raised its tail into the warning position for a moment. Obviously it didn't want to be separated from the thing.

"The box itself was badly dented," she continued, "probably by contact with the rocks when the creature came ashore. It measured about fifteen inches square and six inches deep. One of the large faces was covered with thin padding and hollowed out to accommodate the curvature of the creature's upper chest and neck. On the opposite face there was a six-inch circle recessed about a quarter of an inch. There were four straps to hold the box in position, but I couldn't understand how the fastenings worked. It weighed very little, no more than two pounds, and I thought that it must be some kind of life-belt or container for emergency rations, certainly not a weapon."

"And you are, of course, an authority on extraterrestrial weapon systems," said Matlock sourly.

"Please go on, Sister," said Doctor Watterson, ignoring him.

"There isn't much more I can tell you about my feelings," said Sister Augustine. "With so many armed men charging about the countryside, not quite knowing what they were looking for, I was afraid of the creature being shot before questions could be asked, and I decided to keep its presence a secret for the time being. I telephoned the Sister-Provincial to tell her what I was doing, and a sister was sent to her with photographs of the creature to prove that I wasn't having a brainstorm.

"A week later Captain McCloskey arrived," she continued, "and the meeting was as he described it. The news of the creature being here got out, possibly from my phone calls to the sister-provincial being overheard. Shortly afterwards we were besieged by the media, who were much less polite than the army, and I was asked by Sister-Provincial to provide facilities for this program. It was a request I could not reasonably refuse, even though both Sister-Provincial and myself knew that Mr. Matlock, with someone like Doctor Watterson in support, would be using it to discredit me or show that I was mentally incompetent. . . ."

"Mentally incompetent," said the psychologist softly, "you are not."

". . . But now," she went on, "things are so bad that my sisters, who are neither young nor strong, are afraid to go to the town on their daily visitations to the sick. They're being hounded like royal honeymooners, and even the old people they call on aren't safe from harrassment.

"I invoked the rule of sanctuary on the creature's behalf," she added firmly. "The responsibility is mine alone, and it is unfair that others should be made to suffer."

"Let me repeat, Sister," said Matlock loudly, as if anxious to remind everyone that he was still there. "There

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is an easy way of letting your friends, and yourself, off the hook."

"I doubt if your reminder is necessary, Mr. Matlock," said the psychologist. Then to Sister Augustine he went on, "Have you considered, Sister, that your plan for protecting the creature may already have succeeded? Certainly you've attracted more than enough attention to ensure that it is not going to be killed accidentally, in mistake for an escaped zoo animal. The point I'm making is that you have made very sure that no physical harm will come to it."

When she did not reply, he continued, "This creature belongs to another world whose level of technology is far beyond ours, and whose culture and intentions towards us are unknown. The only way to find out is by long-term observation and interrogation in depth. But for that we must first examine it, study its metabolism in detail so that proper food and accommodation can be provided, and then establish, no doubt with computer assistance, proper two-way communication."

He nodded towards Captain McCloskey and went on, "I expect the military will be breathing down our necks at every stage. They will want to know if your creature was engaged on a reconnaissance operation that went wrong, whether it was able to report back before it came down, the strength and degree of hostility of its people, or if there is any hostile intent, which I myself am inclined to doubt. But in time we will have this information, because we have the specialists and the facilities to get it. There is no longer any reason for it to stay here, Sister, so why not go easy on yourself and let the professionals take over?"

Sister Augustine looked down at her hands, wondering why she was continuing to argue when there was no reason to argue anymore. She said, "I doubt whether the creature would find the regimen you've outlined more pleasant than its present accommodation. As I've already explained to the captain, my own view is that the creature is a stranger, a traveler who is injured, frightened, alone and who may be grieving for family or friends who did not survive the crash, and its feelings as well as its intentions are unknown to us. I understand your viewpoint, Doctor, and for the past few days I've been tempted to do exactly as you suggest.

"But how can I be certain," she went on before Matlock could interrupt, "that I've done the right thing here? It just seemed to me that if the creature *was* directed to this particular place, by whatever agency, then surely it was not simply to be handed over by us to the people who were first hunting it and now intend torturing it for scientific reasons. I wasn't confining the creature, because there is nothing of value in the cellars and they are never locked. I was simply trying to protect it until it learned enough about us to decide for itself what it wanted to do."

"But it will never learn enough," said the psychologist gently, "from a few hand-signals, pen sketches and TV programs."

"It had more than that to go on," said Sister Augustine. "Last night Sister Constance and I took it for a walk along the battlements, to show it the forces deployed around us. . . ."

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"Excuse me, Sister," Captain McCloskey broke in. "There was a report of two nuns behaving in a suspicious fashion last night, apparently using the walls and battlements to hide from the airborne searchlight. But they were seen on an infra-red sensor rather than by visible light, and they were unaccompanied."

Sister Augustine looked at Sister Constance, who cleared her throat and said, "We took a calculated risk, Captain. I guessed that you were using infra-red detection because your searchlight was shining all around the convent but rarely onto it. I also thought it likely that infra-red equipment mounted on a helicopter might not be completely shielded from the engine's heat interference, so there would be a consequent loss of image definition. The creature has a very low body temperature, as low, perhaps, as that of the surrounding terrain. That being so, I thought it likely that the relatively much stronger heat signatures of Sister and myself would obscure that of the creature walking between us. If I'd guessed wrong, I'm sure there would have been an immediate reaction from your people."

"There would indeed," said the captain, looking as if he wanted to hide.

"What was the creature's reaction," asked the psychologist, "to all this military might?"

"I had no way of knowing," Sister Augustine replied. "When we returned to the cellar I tried to explain the situation graphically and with gestures, tried to make it understand that I might not be able to keep it and the people outside separated for much longer. But I didn't know what it was thinking, it just went on making bubbling sounds, and I certainly couldn't read its features."

"But Sister," the psychologist said excitedly, "this means that you *knew* you would eventually have to give up the creature, knew all along! I realize now that invoking the rule of sanctuary was a masterstroke, and you deserve every credit for that, because it made us all stop and think when we could so easily have made the worst mistake in history. Can I assume now that you're ready to give it up?"

"I can't," she said.

The psychologist gave a heavy sigh of irritation. Matlock slapped the desktop in exasperation and said coldly, "You mean you won't."

Sister Augustine took a deep breath and thought *Here it comes*. "I can't," she said, "because I don't know where it is. Just before this program began I was told that it had left the convent. It isn't here."

"I have to report this—!" began the captain, jumping to his feet. Then he sat down again more slowly and added, "This program is going out live, so my people already know about it. But how was it able to get away, in full daylight, without being spotted?"

The monitor was showing her face in close-up, thin, lined, wrinkled, and with her intense embarrassment making the parchment-yellow skin glow with apparent good health. Looking down at her hands again she said, "Another reason I didn't want too many lights in the cellar was that, behind all the junk, there is a passage leading down to the sea. To a small cave that is submerged at high tide, and a tiny beach the sisters

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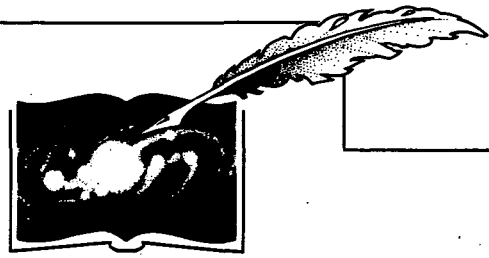

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used to bathe from before a rockfall partly blocked the cave mouth and spoiled the beach. I think, judging from its injuries, that was the way our visitor came and left."

"But why didn't you tell us sooner, dammit?" said the captain, forgetting his impeccable manners for a moment. "Did you want it to have more time to escape, was that the reason?"

Sister Augustine did not reply.

"The reasons don't matter now," said Doctor Watterson bitterly. "This added delay was totally unnecessary and inexcusable, Sister. Because of it you have robbed us of the only chance we're likely to have to examine, study and communicate with a member of an intelligent extraterrestrial race."

"Maybe not, Doctor," said the captain. "It hasn't a hope of hiding on land, and if it stays in the sea we have underwater search and rescue equipment that hasn't been deployed yet because we thought we knew where the creature was." He directed another angry look at Sister Augustine. "I only hope it doesn't panic and get itself killed trying to avoid rescue. But why did it leave? Where can it go?"

"Nowhere," said the psychologist grimly. "Maybe Sister Augustine is a better communicator than we think, and she made it realize what a rescue by us would entail. Close confinement by completely alien beings, continuing and painful probing into its mind and body, because we can't risk using Earth anesthetics on it, and the process would probably last for the rest of its life. If the positions were reversed, I would think seriously about allowing myself to be rescued."

For a long moment nobody seemed anxious to speak, until Matlock pointed an accusing finger at her and said, "It seems to me that in your misguided attempt to give this creature sanctuary and keep us from it, you may well have driven it to suicide. Now, Sister, not only does your own religion's teaching regarding suicide place you in an invidious position, but I wonder how you can possibly justify your—Sister, another interruption! Don't any of your nuns do as they're told?"

The study door had opened again and she could see Sister Agatha, the most senior of her counselors, waving urgently at her from under the outstretched arm of the sound engineer. Sister Augustine rose from her chair quickly and said, "At this moment, Mr. Matlock, an interruption is welcome. Excuse me, I'll be back directly."

As she was returning to her seat several minutes later they were all staring at her, Matlock with angry disbelief; Sister Constance and, oddly, the captain with sympathy; and Doctor Watterson with that clinical look usually reserved for patients whose behavior is giving cause for concern, because Sister Augustine was smiling broadly and she could not help laughing out loud as she sat down.

"Please, Sister," said Matlock furiously, "won't you share your little joke?"

"Glad to," said Sister Augustine happily. "It seems we have all been a bit premature regarding our visitor's departure and emotional balance. Sister Agatha tells me that it returned half an hour ago. It has been watching this pro-

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gram on the cellar TV and now it is waiting in the corridor.

"With your permission, Mr. Matlock," she added, "it would like to join us."

Every camera was trained on the creature as it waddled through the door and across to the desk where it moved without hesitation to the position between the two sisters, who slid their chairs apart to give it room. With its four feet planted firmly on the floor and with fresh scratches showing on its scarred upper torso, it rested its arms on the desk. The blunt, alien head turned and it regarded Matlock with two of its three eyes. Its mouth opened widely to show its disconcertingly large and brightly-colored teeth, and soft, bubbling sounds came from both the mouth and the gills. But from the dented box strapped high on its chest there came a perfectly modulated and accentless voice.

"These surroundings are uncomfortably hot for me," it said, "and I must return to the cellar as quickly as possible, so please do not delay this explanation of my presence here with needless interruptions. I will not give my name because your vocal apparatus would have difficulty with it. I am a surveyor, a map-maker, by nature a solitary individual who lacks both the specialist training and the inclination to be an other-species contacter. I tell you this to explain and excuse my bluntness of manner.

"Discovering habitable planets is not a new experience for me," it went on, "but finding one with indigenous intelligent life is a great rarity. That is why I disregarded the regulations and came in for a closer look, at which time my ship developed a fault that could not be corrected while in flight within an atmosphere. I crashed into the sea and the ship broke up and sank. My protective devices saved me from injury and I swam towards the lights of this establishment. But before I found my way inside my body was damaged by contact with the rocks, as was the translation device and distress beacon which is needed to explain my presence to the natives when situations like this arise, and to signal for help.

"Despite the lack of a translator," it continued, "communication on a very simple level was established. I was given food and my wounds were treated by the entities Augustine and Constance, who also provided local tools to help me repair the damaged translator, but without success. Only last night did I realize that they are being threatened by large numbers of people ignorant of the true situation. It was then that I decided to swim down to the wreckage of my ship, where the tools necessary to repair the device were available, so that the people outside could be reassured and their degree of ignorance lessened. Fortunately, the device was restored with the results that you are hearing.

"And now I shall return to the cellar," it said, beginning to move back from the desk, "to await retrieval and the investigation into the loss of my ship which will follow it—"

"Wait, please," Captain McCloskey broke in, making no attempt to hide his eagerness. "That ship of yours. Is it a total wreck? Will your people try to salvage it or—"

"Yes, please don't go," said Doctor Watterson urgently. "I've a million

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questions to ask you. How long before you're rescued? Who or what will come for you? Is there anything we can do to make your stay more comfortable? Are you willing to submit to even a simple physiological examination—"

"Are you in trouble?" asked Sister Augustine quietly. "I mean, will you be disciplined over losing your vessel? Will the punishment be severe?"

"This," said Matlock coldly, "is becoming far too friendly and trusting for words. I, too, have questions. Or rather, my audience all over the world will have questions that I must ask for them, and I feel an urgent desire for reassurance. I'm far from satisfied with the explanation of why you came here unannounced, uninvited and, had it not been for the accident to your ship, undetected. I can't help wondering if your account is not just a story thought up to cover a clandestine reconnaissance mission mounted by beings whose intentions towards us are hostile. I must say that your corroborative detail is good, especially the way you try to gain our sympathy by pretending to be in trouble with your superiors. A nice touch, that. The mark, as we say here, of the true professional. But what is the truth?"

Without giving it time to reply, Matlock went on, "Is there another ship, or maybe a fleet, in the neighborhood? Hiding on or behind the other side of the moon? Are they waiting on your signal to rescue you and clobber us? Come on, now, what was your real reason for coming here? Have we natural resources you are short of at home? Is there population pressure? Or have you a simple, bloody-minded desire for territorial expansion?"

The extraterrestrial stared down at the desk-top in silence. Doctor Watterson's face was red with anger and embarrassment, and the captain was looking both embarrassed and worried. Suddenly, it looked up and said, "I was not trained, I do not know how to answer questions like these."

"So you're just a simple soldier boy," said Matlock sarcastically. "But I intend to get answers. Unless, of course, you think we would be afraid to touch you for fear that your friends would take revenge. Tell me. This might be a hypothetical question, but what would your people do if we were to harm you, or keep you as a hostage against their future good behavior?"

"For heaven's *sake!*" the psychologist broke in furiously. "Shut up, Matlock. Think of what you're saying, and of the impression this stranger must be forming of the human race. These are your questions, your paranoid suspicions and distrust that you're voicing on behalf, I'm sure, of a very small minority of your viewers. This is an extraterrestrial you're talking to, a visitor from the stars, dammit, not one of your crooked politicians or even the defenceless nun I came here, to my shame, to help you discredit. It is you, not her, whose mental processes are suspect."

"Did you say a *defenceless* nun?" Matlock asked drily. He was smiling and looking as if things were going his way at last, with the victim nicely on the spot and an expert witness tearing into the presenter. Quietly, he added, "we're still waiting for answers."

Slowly the creature turned its alien

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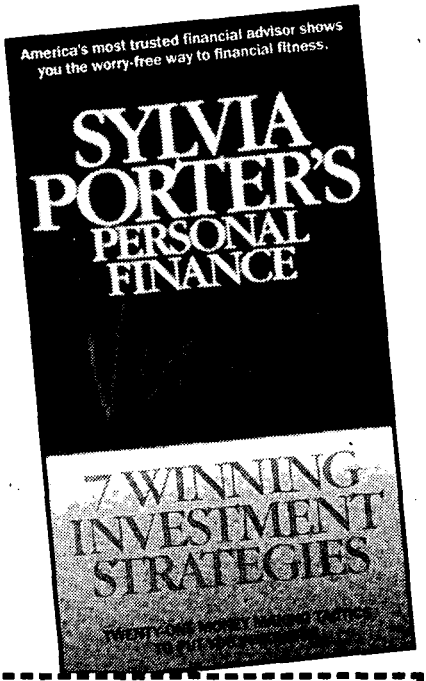
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face towards Sister Augustine and said, "I shall answer your question first, since you have been and are concerned about my personal well-being. Yes, I will be in trouble and will be disciplined over the loss of my ship, and will be forced to listen to many words of criticism. I shall lose a little seniority but gain much personal prestige because, after all, I have discovered the first intelligent culture to be found in nearly three of my generations. So please, friend, do not be concerned for me."

Turning towards the captain it went on. "The cost of returning the wreckage to my home world would be prohibitive, so it will be left as and where it is. The ship's design philosophy is modular so that many of the systems will be intact. They are available for study, with the sole exception of the power unit that our regulations decree must be fused solid so as to avoid the catastrophe which would result if a non-specialist investigated it. I have no doubt that the wise among you will find the rest of the wreck interesting."

The captain sat back in his chair, smiling broadly, and it turned to Matlock.

"It is normal for an intelligent being to approach a new situation with caution," it said, "and to seek reassurance. But reassurance against threats self-generated by an otherwise intelligent mind I am unable to provide, although I think that the entity Watterson is qualified to do so. The concept of an other-species military threat is difficult for me to grasp, but I can assure you that there are more than enough habitable worlds without indigenous intelligent life for anyone to trespass on another species' property, so there is neither a mother ship nor a fleet lurking behind the moon. If I was to be deliberately harmed by you, no action would be taken, since it would be assumed that there were others among your population who might not have wished me harm. However, your world would not be visited again.

"Galactic history has shown," it added, "that a culture with such a pathological distrust of strangers invariably returns to barbarism or perishes by its own hand.

"As for the time needed for the rescue ship to arrive," it went on, speaking to Doctor Watterson, "I estimate that at not more than twelve of your days. The ship will be a little larger than mine, with a crew of two, one of whom will be a specialist in healing in case I should be damaged. Within fifty of your days it will be followed by a larger ship containing the contact specialist and its equipment, which will comprise the communications devices, air-car, food synthesisers and personal comforts necessary for an extended stay. The second ship will not land unless invited by the people of this establishment to join them.

"I thank you for the offer," it went on, "but there is little that you can do for me that has not already been done here. Being prudent and even cowardly, you will understand that I shall not submit to any physiological examinations."

The psychologist laughed. "I suppose it would be like one of us submitting to a witch-doctor."

"Apart from the two exceptions beside me," said the extraterrestrial, "that is an accurate analogy."

"But surely, sir," Matlock protested,

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realizing that he was a minority of one and abruptly changing sides, "you and this contact specialist are the most important people to visit our planet. We would be delighted to provide any facilities you may require, to demonstrate both our goodwill and the level of our technology which is not, of course, as high as your own. Yet you seem to be suggesting that you prefer to stay in this, this antiquated and uncomfortable place among people whose minds cling to superstitions even more ancient and inflexible than the stones of their building. Let's face it, they are not the best advertisement for Earth's scientific and philosophical achievements."

Perhaps the heat was making the extraterrestrial short-tempered because it said very loudly, "It was not a suggestion. It is the rule, a very sensible rule, adopted by all contact specialists. I am not qualified to judge the value of your scientific or philosophical achievements. I can judge only by my direct experience of the superstition which governs the thinking and behavior of the entities who inhabit this structure, and whose behavior and ability to adapt to their unique situation compares very favorably with that expected of full Galactic Citizens with other-species experience.

"The rule states," it went on quickly, "that the entities who welcome and display the generally accepted levels of civilized behavior towards their first off-planet visitor should be requested, if there are no local edicts to forbid it, to extend the same hospitality to subsequent visitors of other species who will, naturally, prefer to be sure of their welcome rather than trust themselves to strangers, however well-intentioned.

"These visitors," it went on, swinging its head towards Sister Augustine again, "would come singly and spend much of their time traveling over your planet. They would use your establishment only as a base, a place of recuperation, and would not trouble you unduly. I could give more detailed reassurances, my other-world friend, but I am most uncomfortable in this room and must leave without delay. Is there anything in your own rules which forbids receiving such visitors?"

Suddenly everyone in the room was looking at Sister Augustine and her face was once again filling the monitor screen. She stared at the extraterrestrials's painted teeth for a moment, and then into its nearest eye. Sister Constance was hunched forward in her chair, wearing an expression that said all too plainly that being principal of a college was no longer the option she favored.

"I cannot foresee any insurmountable problems," she said quietly, "with Sister-General or anyone else. After all, this convent has been designated as a Rest House, and is a place for study and physical and spiritual recuperation. We often receive visitors who belong to other religious denominations, and that would certainly include you. . . ."

Suddenly they were all laughing, even the technicians and Matlock. By the time it died down, the extraterrestrial had left the room for the comfort of its cellar. ■

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SHORTAGE IN TIME

Pauline Ashwell

It might seem that the ability to move about in time bestows unlimited freedom. But nothing is really unlimited. . . .

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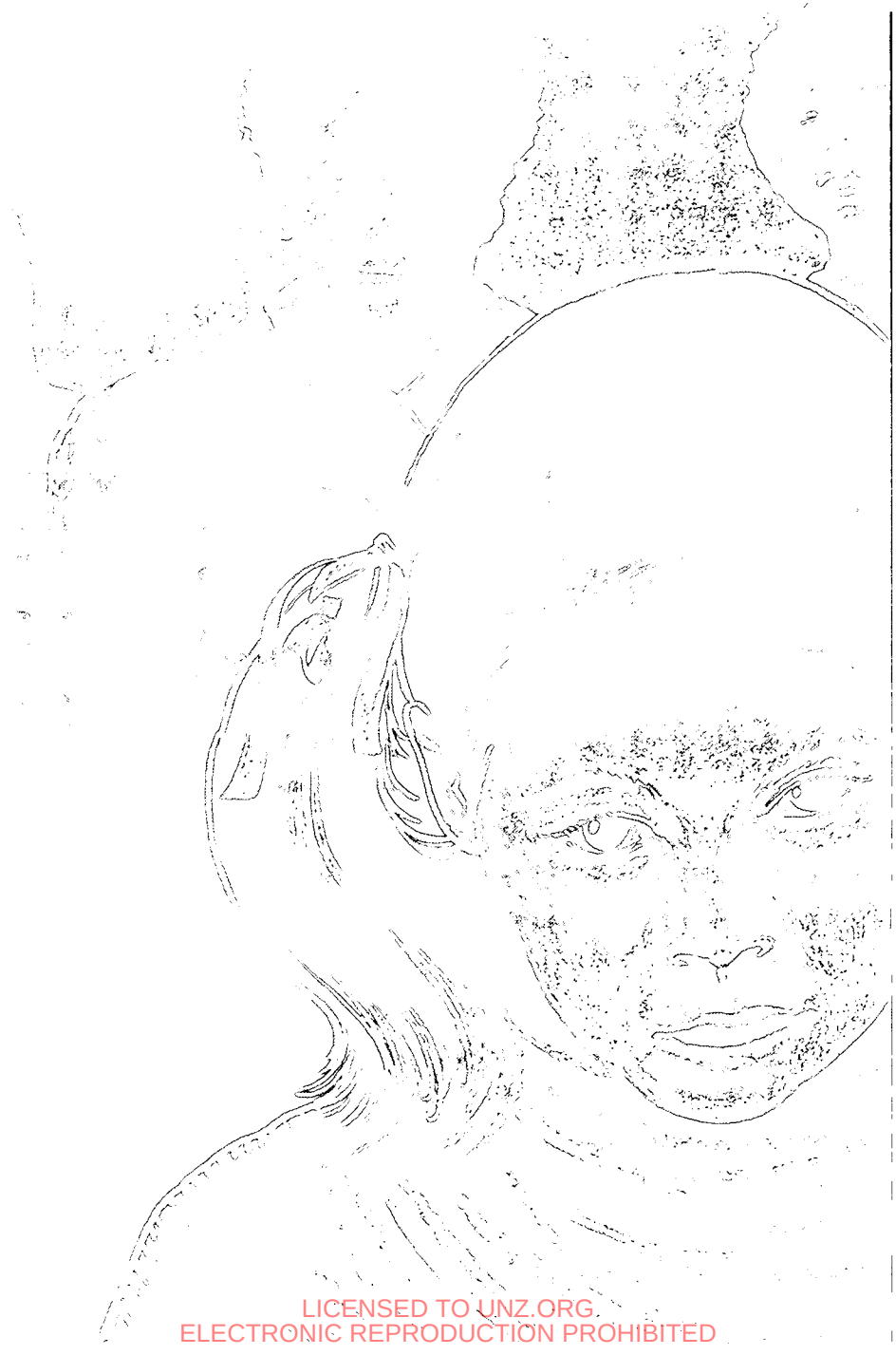

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"It's no good, Schocker," I said, "you'll just have to Take Me To Your Leader."

Damn. I'd done it again. Schocker's English was strictly basic. *Why* did I have this urge to talk to him in jokey cliches? I started to recast the sentence.

"You wish to talk to Dave?" Schocker said.

I'd forgotten the novels he ploughed through in his spare time.

"If Dave is the man who . . . who advises you about life here," I said, "then I wish to speak to Dave."

"He told me you would."

Schocker leaned forward and tapped three keys on the largest of his consoles.

"Soon Dave will come," he said.

I had known Schocker for five days. We had met because I needed a hall in which to hold the District Science Fiction Convention, and I'd been told he might have one for hire. Which was true; only it turned out to be in another Universe.

It was an artificial Universe, brought into being and then colonized from Earth. Because its dimensions of time and space had one point-instant in common with Earth's (I am only repeating what I was told) it was possible to establish a contact plane between Schocker's Universe and any selected point-instant on Earth. Having established the contact plane, one could set up a Gate through it and walk across. I believed this because I had seen it done.

Once I got over the various associated shocks, it seemed to me that after a few modifications, such as street doors that opened and shut (I had been taken in through an unbroken partition; the experience was painless and at the time I didn't quite take in what was happening, but it was not what my fellow committee members would expect), Thingummy Hall would accomodate our convention very nicely.

(The committee member who first mentioned the hall has no memory for names. It must be fairly obvious why I don't give the official, registered, yellow-pages designation.)

That was at about a quarter to two. I was busy all afternoon trying to sort out personnel complications in one of the County Council's homes for handicapped children, and it was about a quarter to six before I had time for second thoughts. These were followed at intervals during the night by third, fourth and fifth thoughts. By morning, I was a total wreck.

I had now got to number twenty-seven or thereabouts and could take it fairly calmly—I mean I no longer worried that Thingummy Hall might be a front for something intending to Take Over the World or Exterminate Humanity, or at least not very often. There must be so many fronts more suitable for that kind of activity than a run-down cinema converted to a conference hall in a smallish county town.

What did worry me was that on Sunday afternoon the other members of the convention committee were due to inspect the premises.

Compared with the hotel which we had used previously (now shut down for major repairs) the main meeting-hall and the three smaller public rooms were positively palatial. I'd coached Schocker in what to say about bar service, catering, first aid, and fifty other topics. I'd helped him to apply for the installation

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of pay telephones (there was already a phone in his office, left over from previous use) and for a public use certificate; I'd explained about fire exits and fire extinguishers and they'd been installed, ready for inspection.

However, some members of the committee were bound to come up with a problem I hadn't thought of. At least two would consider it their duty, as well as their pleasure, to go on probing until they did.

The problem then would be to persuade Schocker *not* to go and deal with it straight away. More power sockets, an extra rod for hanging disco lights, a larger exhaust fan for disco smoke? I had just spent fifteen minutes trying to explain that if he provided these things by a few taps on his magic console, while the committee were still on the premises, he would *not* be reassuring them as to his competence but startling them out of their wits. He was willing to listen, as always, but I could see that it hadn't sunk in.

Hence the demand which was shortly going to produce Dave.

I was looking for him to come through the wall behind Schocker's desk, since that was how Schocker had gone (and returned, I *think* an instant before he disappeared from view) when I had given him a problem difficult enough to require consultation in his home Universe. I was mentally spelling his name Daiv or Daeve and I think I imagined a tall spare figure dressed like one of the more conventional Time Lords from *Dr. Who*. What I got was a forty-fiveish light heavy-weight, of dissipated appearance and running rather to flab. He was dressed in T-shirt and jeans and he entered by way of the door I had used myself twenty minutes before.

"You're Maggie Marsh," he told me briefly. "Schocker, Dr. Wang's still with Carmel. He'll see Harry later. Let's go somewhere else, shall we? *After* you." This last to me. I was surprised to find that I was on my feet, presumably got there by sheer force of personality—his, I mean.

I preceded him obediently through the door, which, occupying the former position of the box-office, opened into the very front of the building. Just behind it was a wooden screen which concealed the rest of the foyer; just in front, the glass doors opening on to the street.

"One of the problems—" I began.

"Not yet, d'you mind?" he said huskily, and cleared his throat. "I've got to get some kip. Can you take me to a hotel?"

I said *"What?"*

He leaned back against the wall. "Look, I'm *sorry!* But I've had two hours sleep in the last fifty, and I'm dead on my feet. I *know* you want to talk to me, I *know* it's important, but right now I couldn't make sense. We'll talk tomorrow, OK?"

I looked at him more closely. The bloodshot eyes and unhealthy complexion which I had taken to show dissipation could, on second thoughts, just as well be due to exhaustion. Why he should have got into such a state I could not imagine. If I had understood Schocker correctly, anybody in the other Universe who needed time off from urgent commitments *there* could slip off to some peaceful spot in another time-stream, stay there as long as he liked, and return

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to the very instant from which he had departed. . . .

I said, "there's a spare room in my flat. You can have that if you like."

"Thanks," he said. "I hoped you'd say that." He picked up a small and battered suitcase which was standing by the glass doors, and waved me through them.

This time, second thoughts began about five seconds later. I wondered just how stupid I was being. However, his potential (if any) as a menace had been cancelled by fatigue. Stopped at a red light a couple of minutes later I watched his reflection in the wind-screen slump gradually towards the floor. He reached the angle of rest before getting tangled in the gear-lever, so I left him alone until I reached the car-park behind the flats. There, I shook him sufficiently awake to get himself out of the car and to close his fingers on the handle of his case when it was pushed into them, and led him inside and upstairs.

Having made up the spare bed, I got him sufficiently awake to shuffle along the corridor and to sit down on the bed. There, he collapsed slowly sideways, rolled over a little and dragged his legs up after him. I removed his shoes, and left him.

A couple of hours later, as I was peacefully ignoring something or other on the television, I had a visitor.

Most of the members of the convention committee were old friends, or at the least long-standing acquaintances, and had a tendency to drop in with minor problems, but not Kevin Smallweed, and I wondered what was urgent enough to have brought him. Fifteen minutes later I was still wondering. So far as I could see any of the items he brought up could perfectly well have waited till the next meeting of the committee.

Not all of the older members of the committee had welcomed the idea that teenagers should have a special representative. It was only reasonable—they made up at least a quarter of the membership, there was no reason why their tastes shouldn't be catered to and every reason to doubt that committee members reared on Jules Verne and H.G.Wells understood what those were. In the event, the various fears voiced before Kevin's first attendance had proved to be groundless. He did not lengthen meetings by unnecessary chatter, but said what he had to say concisely and clearly; and if he undertook to do anything it got done. It would have suited me if some of the others had been more like him.

One fear expressed before he had made his mark on the committee was that Kevin might become unduly familiar; a couple of the less tolerant members adding that they didn't want to be publicly accosted by a scruffy-looking specimen like that. Kevin was not, strictly speaking, scruffy—his mother saw to that —but unlike most teenagers, he was not interested in clothes. He gladly wore the cast-offs of several older brothers, in order to save his money for the things that did interest him. His clothes were not only out of fashion, but out by varying numbers of years—jacket, shirt and trousers all following different trends.

Kevin was quite well aware that his clothes were not smart. His friends told him so, loudly and often. It did not stop

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fellow teenagers from voting him in as their representative on the convention committee and it had never made the slightest dent in his self-confidence.

As for familiarity, he tended to keep the rest of us rather at arms' length—not a bad operating position, in many ways, but I guessed it was giving him trouble now. However, the only thing to do was wait and let him get round to whatever was bothering him in his own time.

He did so, fairly suddenly, while I was still looking through the minutes for the answers to his last question.

"This place you want to hire —Thingummy Hall—that's the old Plaza Cinema, right? Know anything about the owners, do you?"

I sat up with a jerk.

"Not a lot," I said cautiously. "Why?"

Kevin studied the bottom of his teacup.

"Well, mind you, it may not have been the owners—maybe they just hired the place out."

"Who to?" I said sharply. "What are you talking about?"

The last thing I wanted was for anybody to start asking questions about Thingummy Hall, and of all the committee members Kevin was the one I least wanted to do so.

Apart from his talent for leadership, which went with a good deal of energy and very considerable intelligence, his outstanding characteristic was paranoia. At least, that was how I classified it when I first became aware of it. Happenings which other people put down to chance, stupidity or general cussedness he always interpreted as being part of some sort of Plot. It was some months before I began to see that surprisingly often he was right—not just about governments and politicians and big business, concerning which the newspapers provided more evidence every day, but over specific and local matters. He had overcome his general reluctance to get involved with his elders in order to warn me that the son of the owner of a market stall where I often bought vegetables was selling pot on the side—he seemed to feel that it might reflect on me, as a council employee—and a week later the boy was arrested. He voiced suspicion that a certain ultra-Tory house-holder was involved with a right-wing paramilitary outfit, and three months later he was convicted of posessing many more guns than he was licensed to own.

These and similar incidents had convinced me that Kevin was a person to be taken seriously. If he had got the idea that there was something to investigate at Thingummy Hall it would be an appalling nuisance and could leave me looking for somewhere else to hold the convention—and I'd already established that there was nowhere else available. And if by any chance there *was* anything going on—I mean anything nefarious that I didn't know about—I would be landed with a much worse responsibility.

"If there's something wrong with that place, Kevin, for goodness' sake tell me," I said.

"Well, no," said Kevin reflectively, "not so much the *place* . . . Look. It was last year some time. There was kind of a seminar or something at the Plaza, lasted a couple of days. Something to do with youth, the name was—the or-

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ganizer's name. The seminar was called *Where Should We Go From Here?"*

"I heard about it," I said. The county council's Education and Social Welfare Departments had both felt that they ought to have been consulted. However, nothing particularly untoward had happened, so far as I knew. There had been the usual exhortations about developing bodies and minds together, according to the local paper, along with what seemed to me some fairly intelligent stuff about possible lines of development for the Leisured (i.e. Unemployed) Society.

"Lot of the unemployed kids gave it a try," Kevin continued. "Didn't cost anything, see, and they thought there might be a chance for a lark. Well, there wasn't, place had as many bouncers around as a big disco, but most of them stayed on. It was mostly discussion groups. What do you really want from life, how do you set out to get it. Course, half of the kids couldn't think beyond money to get a bigger bike, but some of 'em were quite interested. The organizers didn't try to elicit the answers they thought they ought to be getting from that age and social group, know what I mean? They asked a hell of a lot of questions, though, before you were allowed to join. Great long questionnaire about what they called background. Family, education, opinions, like that. One or two kids who gave made-up answers didn't get in either."

He compressed his lips, stopped talking, and started to play with his teaspoon instead.

"There's nothing very sinister in all that," I said.

"Nope. Well, nothing went wrong *at* the seminar, that I know of. Only afterwards, one of the girls said there was something going on behind it—like the organizers weren't just trying to promote social consciousness or awake latent abilities and that stuff, they were trying to pick out a few particular kids for something. And two of the kids that went to it have disappeared."

His tone was studiously matter-of-fact, but it gave me—as he meant it to—a nasty little jolt.

"Missing persons disappeared?" I said. "I mean, have the police looked for them?"

"I don't reckon, no. They didn't either of them have much of a family. One was fostered, and she turned eighteen, so it was no one's business when she took off. The other, his old man's in and out of the alcoholic ward and his ma went to Ireland with her boyfriend and doesn't write."

The usual bleak sort of background . . . Kevin caught my reaction.

"Look, they weren't either of them likely to take off, not just like that. Nobody was hassling them. And kids who think they can end up better off just *pulling out, without anywhere to go*, are plain daft, and those two weren't daft. They were bright, both of them, top of the class, and they'd got sense as well. Linda, she'd been accepted for a secretarial course, and one of the teachers at the school was trying to get Brian into the Poly. One of his A levels wasn't so hot but the other was good and he thought he'd get a place."

"They cut admissions to the Polytechnic last year," I said, briefly summarizing an economy measure that had

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caused anguish and disruption among local educationists and their charges.

"Yea, I remember, but Brian was gone before they announced it."

"I don't see any reason so far for connecting their departures with the seminar at the Plaza."

Kevin gave me a Look. It said a lot about the generation gap and the general uselessness of talking to one's elders, and it stung.

"Maybe Brian's mother invited him to Ireland. Maybe Linda went off with a new boyfriend. That happens."

Kevin, visibly, decided to give me a last chance.

"One thing about Linda; she wrote letters. All the time. When she was on holiday she wrote to her pals every week. But since the seminar, nobody's heard from her—not once. And Brian, he had a couple of books he kept in his locker at school, so his old man chouldn't tear them up. Real keen on them, he was. Start of this term, teacher was asking if anyone knew his address, because when the locker was cleared out they found he'd left the books behind."

"That's worrying," I said, sincerely. "I don't see how you connect it to the Plaza, though."

"Maybe not," said Kevin briefly. He got to his feet, "Well, thanks for the tea."

I thought for a while about the young and the problems of communication and then went to bed. On the way I looked in on Dave. He was still flat out. I dropped a summer-weight duvet over him and went to bed.

The next morning, Saturday, I had no need to go into the office. I got up at eight o'clock and was peacefully preparing breakfast when the buzzer sounded in the hall.

I picked up the phone which connects with a microphone beside the front door and said "Flat 3."

A deep, angry voice said "I need to speak to Dave Clarke!"

About to tell him he had the wrong address, I suddenly remembered the contents of my spare room. Dave's surname had not been mentioned, but there seemed no reason why it couldn't be Clarke.

"Your name is—?" I said.

"Peter Hardingson. Tell him it's urgent!"

"And you are—?" I prodded.

"What do you—? Oh. I'm in charge of the Purchasing Department for this area."

Schocker had said the Plaza had been bought originally by the Purchasing Department as a place from which to transmit goods to the other Universe.

I said, "I'll find out if Mr. Clarke can see you."

Mr. Clarke at the moment was not seeing anything, unless maybe in dreams. I leaned forward and touched gently behind his ear. This method of waking people is recommended by John Buchan; my adolescent enthusiasm for his books is something of which I am now, on the whole, ashamed, but on this point he is sound. Dave's eyes opened peacefully on the world; he gazed for some moments at the stretch of pillowcase immediately in front of him, then rolled over and caught sight of me.

His eyes stretched open; then he sat up with a jerk. His mouth opened too, but nothing came out.

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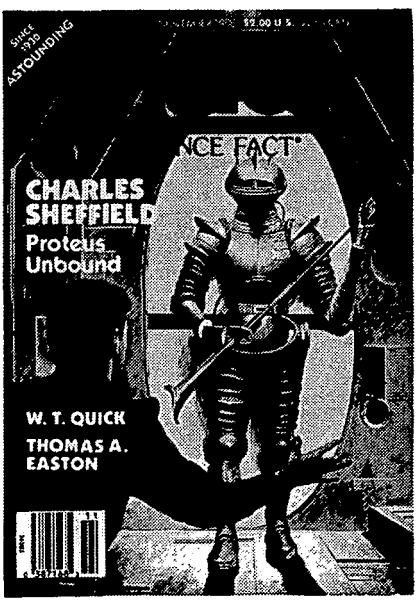

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"Maggie Marsh," I said helpfully. "The one who wants to rent Thingummy Hall."

Dave made a rusty noise at the back of his throat. I poured some water from the carafe I had remembered to fill the previous night, and held it out.

"You have a visitor," I said while he drank it. "He says his name is Peter Hardingson."

Dave lowered the glass and stared.

"A *visitor?*"

"He says he is in charge of the Purchasing Department in this area."

That connected. Dave's face twisted into a grimace.

"Also," I continued remorselessly, "he says it's an emergency."

"It would be," said Dave. "Where is he?"

"On the doorstep."

"Oh, well, tell him—I mean, would you mind telling him I'll be down in a couple of minutes?" He threw off the duvet. "I suppose there's a cafe or something in the neighborhood where we can go and talk?"

"No need for that," I said. "You can talk to him here."

Two reasons. Firstly, curiosity. Secondly, if he had not yet eaten my bread and salt he had slept under my duvet, which made him a guest and entitled to protection.

I found that he was not apt to need it in any physical sense. The voice had misled me. If Peter Hardingson went in for boxing he would have to enter as a bantam-weight. To be fair, he looked in good enough physical condition; despite the city gent's striped trousers, black coat and shallow bowler, which struck me as quite the silliest-looking of civilian uniforms.

"Mr. Hardingson?" I said. "Please come in."

My flat is one of four in a converted Victorian mansion. The staircase is on the imposing side. I preceded him up it with a stately tread, hoping the set-up would exercise a quelling effect. I put him in an armchair in the living room, had my offer of coffee accepted—a hopeful sign, unless he thought in terms of throwing it—and went to see how Dave was getting on.

He had accomplished quite a lot in the last few minutes, including a shower, a change of shirt, and a comb through the hair. His preferred beverage was tea. I withdrew to the kitchen and assembled a tray.

Shouting started just as I was pouring water on to the tea. I didn't recognize the language.

I sailed in, thumped down the tray, and said, "Be quiet."

They broke off in astonishment.

"The party walls between this flat and the next are on the thin side," I said. "If you must yell, speak English. I don't want my neighbors to think I'm harbouring the IRA."

I gave Peter Hardingson his coffee. Dave got up and decanted the teapot into my outsize mug.

"We'll speak English, anyway," he said. "Miss Marsh wants to know what's going on."

Hardingson drank some coffee the wrong way.

"Wants to— You mean she *doesn't speak Standard—!*"

"Nope."

"Then she's a— a—"

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"Native," I suggested.

"Local," said Dave.

The small man rose to his feet and tried to tower over the larger one.

"In Time's name, Clarke, what do you think you're doing? I got back from Germany last night to find my desk covered with memos about someone from *maintenance* who's taken over the old Plaza building without so much as a by-your-leave, filled the top floor with half-wits and started requisitioning all kinds of services. It's taken more than a century to build up Brown and Green as one of our most important purchasing facilities. You've already endangered it. Now you want me to confide in a—a—"

"Local," said Dave again. "One of the services I requisitioned was to have her checked out, didn't you read the report? Anyway, she knows all about us already, don't you, Maggie?"

"I know that you both come from another Universe," I said. "Also that you can step into this one at any point of history that suits you—on Earth, anyway. Also that your Universe is artificial and on the point of breaking up—"

The absolute improbability of what I was saying swept through me like a cold wind. Once, when I was fifteen, I nearly fainted. This was the mental counterpart of that feeling.

Through it, I was aware of my voice going calmly on; five years of reporting to county council committees was quite good training for this sort of thing—

"—and that since you can make use of long stretches of time—multi-million-year stretches—you've been able to terraform a number of planets. Twenty-three, I believe. The population of your Universe has now been evacuated to these, except for a few hundred people who have stayed on to wind things up. Dave's one of them. During the winding-up process they found a group who had been isolated for several generations—those are Schocker's people, the ones hidden in Thingummy Hall."

"Couldn't have put it better myself," said Dave. "You see, Peter, the beans have been spilled, so—what's the matter?"

"*On the point of breaking up?*" Hardingson's face was crimson. "What's she talking about?"

"Didn't you notice the date on my memo?" said Dave. "Four months from Dissolution."

I never saw an inter-departmental row collapse so fast. Harding's color faded as I watched. In a sort of croak he said "*Dissolution?*"

"Yes. Never mind that; we can go into it later. You told Mag—Miss Marsh there was an emergency. Let's deal with that first."

"*Right,*" visibly, Hardingson's sense of outrage returned. "As managing director of Brown and Green, I got a phone call at six this morning. From the police. Last night a patrol car went to investigate reports of a prowler around the old Plaza building. They arrested a young man who refused to account for himself, or in fact to make any sort of statement. . . ." The flush of rage, though only a shadow of its former self, started to return. "Clarke, if one of those half-wits you've parked in the top of that building is in the hands of the police—!"

"Oh, that's what's eating you."

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Dave thrust his hands into the pockets of his jeans and scowled thoughtfully.

"They said he was oddly dressed."

"Did they? We needn't worry about that, then." Dave got up and stretched. "My lot are wearing jeans and T-shirts and trainers, like anyone else that age. Must be some other lad—" He raised a large hand, forestalling comment. "But I'll ring Schocker and get him to check— No, damn it, I can't. He isn't there."

"Where is he?" I demanded. Schocker wandering about on his own—

"Elsewhere," said Dave briefly.

It sounded like a snub. He saw my reaction and added, "that's what we call the other Universe. Didn't he tell you?"

Well, it was logical, I suppose.

"Clarke!—" Hardingson's color was almost back to full brilliance—"do you mean those—those—"

"Try 'innocents,' " Dave suggested. "Their grandparents decided for some reason to separate off from the rest of us, and took over an empty unit, deleted it from the memory of the main computer and set up a community of their own. Didn't have a name, so I called it Shangri-La—"

"Naturally," I said.

"It was damned traumatic for all of them, suddenly being rediscovered and told they'd have to get out, but they aren't half-witted or anything like it."

"Whatever they are, do you mean to tell me that you've left them up there, *unsupervised?*"

"No, I don't. There are four psychologists, two behavior experts, three local-environment experts and a linguist up there as well. Schocker doesn't supervise them, he looks after the office. Trouble is, none of the others would answer the phone."

"What did you tell the police, Mr. Hardingson?" I enquired.

He reacted as though he had been addressed by one of the chairs.

"I—what—er—Oh. I told them one of our executives—*junior* executives—was in the area, and I'd get in touch and tell him to call round to the police station."

"Meaning my cousin Dave Clarke who's staying with me for a few days' holiday?" I said.

"Not bad," said Dave, before Hardingson could suggest that chairs should be seen and not heard. "Thanks, Cousin Maggie. How are your connections with the local cop shop?"

"Cordial, on the whole."

"How about ringing them up and making enquiries on behalf of your visiting cousin, the junior executive?"

"They'll be pleased to see us at half past ten," I said, five minutes later. "It'll take ten minutes to get there, so that leaves half an hour for explanations."

Dave uttered a faint groan. "All right, if I must. What do you want to know?"

"*Why* you put Schocker and the others into that building? It doesn't make sense."

"That's what I want to know, too," said Hardingson. "Why was a man from *Maintenance—*

"All right, all right." Dave drank the last of his tea. "Look. By the original plan, everybody in Elsewhere should have moved on to whichever planetary colony they chose, by now. Then it oc-

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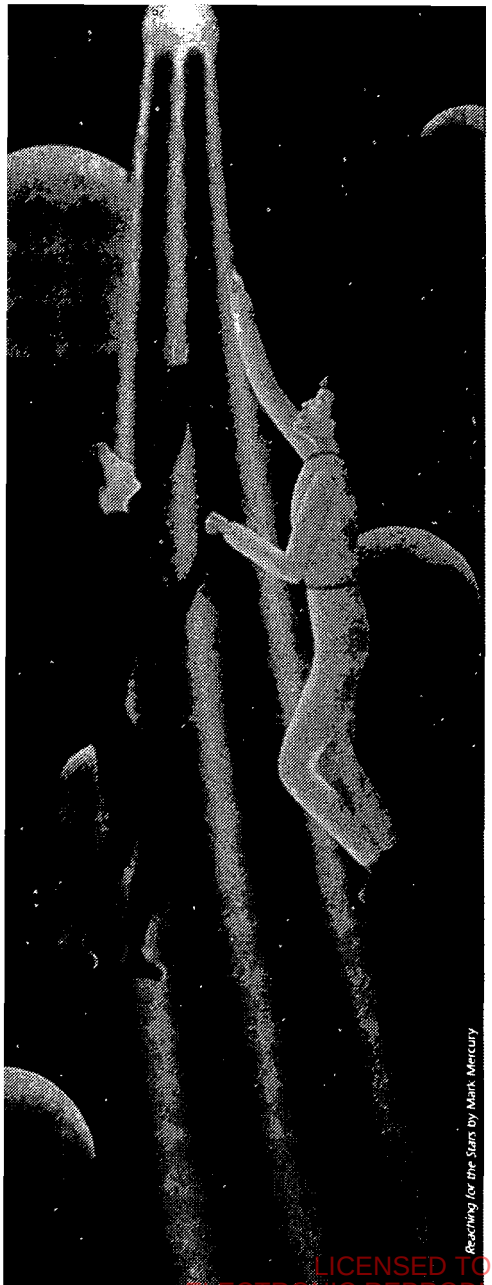

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curred to somebody that a lot of equipment and facilities would be left behind. It was decided that instead of wasting them they could be kept available for emergencies on the settled planets. Anything the new colonies weren't equipped to handle, like an outbreak of a new disease—"

"Or the sun going nova?" I said, fascinated.

"Do you mind? The planning was better than *that*. None of the colonized suns will go nova within a hundred million years—that's as far as the astronomers checked. They couldn't be sure a supernova wouldn't break out close enough to be dangerous, though, or that there wouldn't be unpredicted earthquakes or tsunamis, not to mention the kind of problems a few million people can generate among themselves. So the planners decided to leave a group in Elsewhere for as long as possible, to handle that sort of thing, and asked for volunteers."

"But did they expect much of that sort of thing in the first four months of colonization?" I asked.

"Four months in *Elsewhere*," said Dave patiently. He saw I didn't understand, and added, "the planets are in *this* time-dimension. Appeals for help from any of the colonies are received at a contact plane that puts them through one after another, every thirty minutes. Latest one I heard of came from seven hundred years after colonization started."

I added this to the list of things to be worked out later. Dave was going on, "whoever's on duty when the message comes through, handles the job. He can call on anyone he likes to help, but he's responsible for organizing the action. Damn it," he added crossly, "I wasn't even *in* the group, not really. They wanted a couple of people from maintenance to keep the equipment going. I volunteered for *that*."

He drank the remainder of the tea, and choked on a stray leaf.

"Then why," said Hardingson coldly, "are you in charge of these people?"

Dave sighed profoundly.

"Because I *found* them, and nobody would take them off my hands!"

"How did that happen?" I asked presently, to help things along.

"Oh . . . I was checking the Units . . . " He glanced at me. "Did Schocker explain how Elsewhere is laid out? Well, it consists of separate Units, pretty well self-contained. Each of them's like a damn great space ship, really, with its own gravity generator and life-support system. There's no physical connection between them; we get from one to another by Translocator."

I made a mental note of the word *Translocator*, but didn't interrupt.

"A few days after the deadline we found that some of the people who ought to have left were still around. Got doubts about their choice of colony, or just couldn't make up their minds to go."

"Surely, that was their own responsibility," said Hardingson

"Yes, up to a point. Trouble was, most of the Gates to the other planets had been shut down. The remaining ones could cope with a few laggards, but not with a panic rush of hundreds at the last minute. So it was decided to check how many there might be. It was a maintenance problem, more or less, so I got stuck with it.

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"I queried the computer in charge of food distribution."

Dave turned to me. "The Units aren't self-sufficient for food. That comes mostly from hunting and farming outfits in various prehistoric areas, plus bulk purchases of some items. Once it's come into store the distribution is entirely automated. Each Unit has a special Translocator for food deliveries.

"The computer reported deliveries to about sixty Units, apart from the six occupied by the emergency team. Most of them corresponded to individuals who were still hanging around for one reason or another, but one was a whacking big order, enough for twenty people at least.

"The code of the personal Translocator for that Unit had been deleted from the list, but I dug it out of the computer in the end and went charging into Shangri-La, and ran straight into a bunch of *kids*. I don't think any of that lot was over twenty years old." Dave shook his head."

"Don't you have twenty-year-olds in Elsewhere, then?" I was puzzled.

"Not now. There hasn't been any recruitment for the last five years, and the minimum age for it was eighteen. And nobody raises children there—people who want to start a family go to a colony first. . . . So this lot was a bit of a shock, but nothing like the shock I was to them. They literally had never seen a strange human being in their lives."

"What about their parents?" I asked.

"There were five survivors from that generation, all in their forties. They'd never been outside Shangri-La either. *Their* parents—three couples—had simply taken over an unoccupied Unit, got it all fixed up and then cut it out of the Translocator system. Their descendants didn't know why, except that it was something to do with religion. The third generation didn't even know that, which was probably just as well—they had enough to contend with. It would have been hard enough for them to adjust to the rest in Elsewhere; but I had to tell them they must move out altogether."

I drank some tea to see if it would clear my head. It didn't.

"Why exactly was that necessary? Why couldn't they stay in Shangri-La until they were used to the situation?"

"Because," said Dave patiently, "we were running out of duration. There was only four months left altogether, and they might need it for all kinds of things. I had to save as much as I could.

"Duration?" I said. Peter Hardingson made a snorting noise.

"Clarke means," he said, "that Elsewhere was not going to last long enough for these people to undergo the necessary psychological treatment there, so part of it would have to take place somewhere else."

"Not just that," said Dave. "They'll need special training for whichever colony they go to—none of the colonies is organized to take them without it. That'll have to be done in Elsewhere. We've got to get as much as possible done in *this* timeline, so as to save time in Elsewhere for the things that can't be done anywhere else."

"Yes, I daresay," said Hardingson restively, "but why in Time's name do you want to do it *here?* Surely one of the Resorts—Avallon or Point Return—"

"Time there's all been used up."

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Hardingson spluttered., "What on earth do you mean?"

"Look, all the resorts were set up in places with a limited life-span, so as not to leave any remains that could cause confusion in historic times. Avalon was just the last of half a dozen that were built on islands in the Lias Sea; none of them lasted more than two centuries. Hurricanes—Avalon was due to be blown away after a hundred and forty-seven years. Well, every last available minute was used up—people just went there again and again. There was a farewell party the whole of the last week. Some of the fools insisted on staying on till the hurricane struck and got out by E.T."

"What—?" I began.

"Emergency Transtemporator," said Harding impatiently. "Dangerous."

"Same at Point Return, except that there it was a new volcano breaking through in one of the paddocks. Everybody got back safely, so far as I know. . . . The point is, there was *no time available* for the kids from Shangri-La. I knew of the old Plaza—it was the *only* place I knew of in this Universe where there was accomodation, and privacy."

"Yes, but—"

"You don't have to worry about damage to Brown and Green. I read the file. They've got another twenty-five years to flourish before they're wound up." Dave got to his feet. "Time to go and see the police."

Driving Dave to the police station, I tried to sort out the questions I had to ask from those I could answer myself. For instance, Hardingson presumably learned Dave's whereabouts from Schocker's Ansafone. (Did that mean Dave had been sure enough of my reactions to assume that I'd let him have my spare room? Not necessarily. I'd still have been the person to consult even if I'd taken him to a hotel.)

Dave said abruptly, "there seem to be more problems to this than I expected. . . . We didn't do a lot of time-hopping in Maintenance."

"You seem quite familiar with manners and customs in this period," I said.

"Yes, well, this place-time is one I *did* visit. I installed the Translocators in the old Plaza building when the Purchasing Departmnent took it over. A lot of the work had to be done this side of the contact plane. I spent several weeks here-and-now—well, here and twenty years ago, when Brown and Green bought the place. Five years ago on my personal time-line. That's how come I thought of it when I needed a place to put Schocker and Co. Sheer luck, the original requisition for the work was received more then a century before I got recruited, but Maintenance was very busy in Elsewhere—there's a lot of work in keeping a Universe going, even a little one—and it got filed for future reference. I mean, the work was going to be done when it was needed in *this* place-time, it didn't matter if the work-team had to be prophased a decade or so—"

"Had to be *what?*" I said.

His reply was drowned by a sudden outburst of hooting. I woke to the fact that the car was stationary at a traffic light, now green.

"Save it for later," I said. "We've arrived."

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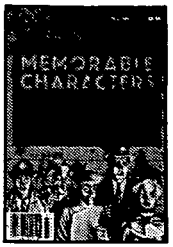

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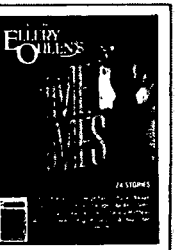

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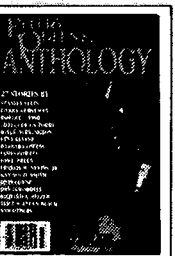

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* * *

Sergeant Smethers and I were old enemies until he discovered that I read science fiction. He has been perceptibly more helpful about security and parking arrangements for council functions ever since.

He did say that the young man collared round behind the old Plaza was rightly CID's business, but since the two CID men attached to this station were both out he was willing to show the captive to my cousin, the junior executive of Brown and Green, just in case he could be recognized as a disgruntled ex-employee; nor did he raise any objection to my tagging along.

My view of Dave's shoulder-blades told me that the prowler was definitely *not* one of the waifs from the other Universe, which was all that seemed to matter. Then he moved aside, and I saw the boy sitting at the Interview Room table.

"Kevin!" I exclaimed. "What on earth are you playing at?"

Kevin Smallweed had not actually been arrested; simply asked why he was nosing round the Plaza; and, when he refused to explain or identify himself, taken to the station in the hope that a few hours' reflection would persuade him of the wisdom of doing so. Once he had confirmed my identification he was allowed to go.

I left the car outside the police station and led Kevin and Dave to a nearby cafe.

"Now," I said, "you can explain what you were doing there. The Sergeant chose to accept that as a member of the convention committee you had a reason for wanting to look at the place, where it's going to be held—"

Kevin muttered something derogatory to the intelligence of the police.

"—But he didn't believe it," I continued severely, "and neither did I. For one thing, if that was all why didn't you tell him who you were?"

"And have *him* ring *me Mum* to come and identify me? Not likely," said Kevin scornfully. "I was waiting for Mr. Collins to come in. He knows me."

P.C. Paul Collins lived in the same street as Kevin's large and, for the most part, law-abiding family.

"That clears that up, then," I said. "All the same, if they turn up anything that looks like funny business around there, in the next six months—make that a year—they'll be on your doorstep straight off, and your Mum won't like it at all. And if anyone's been using the Plaza—misusing it, I mean—for illegal purposes, my cousin's company wouldn't like *that*. And *nobody's* going to like it if the convention gets interrupted by trouble with the police. So if there's anything going on around there, or you think there is, you'd better tell us about it."

Kevin looked thoughtfully at Dave.

"You work for the company that owns the old Plaza—that right?" he said.

"Right," said Dave. "I'm attached to the head office. My managing director knew I was here visiting my cousin, so when the police phoned him to say they'd caught a major criminal on our premises he asked me to look into it."

He grinned. Kevin didn't. Dave took an exploratory mouthful of coffee, put down the cup and got to his feet.

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"Think I'll go and get a paper," he said.

Kevin sipped his coffee.

"Well," I said, "you got rid of my cousin. . . . Is this something about your friends who've gone missing — Linda and whats'it—Brian?"

Kevin went on sipping thoughtfully for several moments.

"Thought you didn't know anything about the people who own the Plaza," he said.

"I don't," I said crossly. "They're a firm called Brown and Green and my cousin works for them, apparently; but until this morning he hadn't been here for twenty years. All I know is that they don't like people snooping round at night, which as they're still using the upper part of the building for storage is not surprising. I haven't asked him about your dark suspicions, because I can't see any reason, apart from innate paranoia, why you're harboring them. Since you're not actually daft I suppose you know more than you've said, and I also suppose that's why you were creeping round the building in the dark, but if you won't tell me about it there's damn all I can do."

If anything, Kevin appeared to find my remarks reassuring.

"OK, OK," he said. "I didn't tell you, because . . . well, it isn't really anything I *know*. More, sort of, atmosphere. Got on my mind a bit, that's how come I went to have a look-see . . ." He sipped again, reflectively. "Course, it wasn't too bright thinking there might actually be something to find there . . . I mean they wouldn't bury the bodies there or anything, would they?"

"*What* bodies, for heavens' sake?" I demanded, shaken.

"Look, the bit I didn't tell you yesterday—well, if you don't know the people it just sounds silly, I guess."

"Never mind what it sounds like," I said. "I've heard plenty of silly things that turned out to be true—and serious."

"Reckon you would have, with your job and all." Kevin appeared to engage in some private meditation. "All right . . . My girlfriend, Marilyn, one of her sisters was in Linda's class at school, and they went to the seminar together. Marilyn just happened to tell her I was going to take a look at the Plaza, with the Committee, and the night after the kid had a nightmare. When she woke up she said it was all about Linda, and it was because of something at the seminar that she'd forgotten. She'd been watching Linda talking to a couple of the organizers, see, and then Linda walked off. *She* was looking excited and pleased with herself; but the two organizers looked after her like they was sorry for her, and one of them said something to the other—Marilyn's sister only heard a couple of words, but one of them was 'sacrifice.' "

I blinked. Then I laughed. Kevin turned slightly pink.

"OK, it could have been sacrificing her career, sacrificing something *for* her career, like that. Except it didn't *sound* like that. So the kid says. It kind of frightened her, only then something else happened and she forgot. But I don't believe she imagined it, she hasn't got the brains."

"Really, Kevin," I said, "this isn't up to your usual standard at all."

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He picked up the coffee spoon and balanced it on the rim of the cup.

"So I'm paranoid, you told me before. You didn't hear her. All right, running off to look round the old Plaza was daft, but it was all I could think of to do, and I had to do *something*, just to get it out of my head. I mean, I read the papers. No good saying it doesn't go on, because it does. Black Mass, and that. And that man Manson in California. There just isn't *anything* you can say. *Nobody would do that nowadays.*"

"All right," I said. "No argument. I read the papers too. But those sort of things are exceptional. They *can* hit anybody, but it's still a lot more probable, statistically, that your friends have just gone off of their own accord. And if by any long chance the organizers of that conference did include the sort of lunatic you're thinking of, there can't be many places less suitable for performing the Black Mass, than Thingummy Hall."

"Prophase," said Dave suddenly when we were half way back to my flat.

My steering veered slightly and I corrected it.

"What?"

"You wanted to know what Prophase means."

"So I did." It seemed a very long time ago. "All right, what does it mean?"

Maybe I sounded less than enthusiastic. The glance he gave me, sideways, seemed slightly puzzled.

"Well." He rubbed his nose thoughtfully. "I don't know if you've had time to think about what it's like, dealing with two independent time dimensions . . . "

I said, "Confusing, I expect."

"That's it! There's nothing to stop you getting wound into a real cats' cradle, unless you make rules and keep them."

"The Rules of Time?" I said.

"Right. What they amount to is, you keep things in order. Take one of the place-times we have a connection with—say the one in Miocene South America that we call Point Return. There's a big ranch there, supplies most of our meat. Now the connection was started on one particular day on each side of the contact plane. Those two days were *in phase*. Two other days, say a week ahead on each side—they were *in phase*, too. You see? And as a general rule contacts with Point Return are made *in phase*."

"I get it," I said.

"Right. Point is, they don't *have* to be. If there's a good reason for it, someone in Elsewhere can set up a Gate connecting with an earlier day than the one that's in phase. Then we say the contact's *prophased*."

I considered implications.

"Does that mean that the job you came here to do had been overlooked for *more than a hundred years?*"

"Something like that," said Dave, without blushing. "When Dissolution was only ten years off someone in maintenance programmed the computer to check whether anything had got overlooked. Several jobs turned up. One of 'em was over two hundred years out of phase. Didn't make any difference to the folk in *this* Universe—the job got done as soon as they asked for it.

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"What would have happened if it had never been done?" I asked, fascinated.

"Couldn't happen," said Dave firmly. "If the job hadn't been started as soon as the requisition was sent, the man on the spot would have raised hell."

For a few seconds I allowed myself to think wistfully about all the repeat requests that got channelled across my desk; but the County Maintenance Department has suffered from cuts like everything else, and it is an article of faith that they do the best they can.

"Was that the turn to your flat?" Dave enquired.

It was simpler to go round the block than to go back. I didn't speak again until we reached the car park.

"All the same," I began, "I would have thought there were times—"

Peter Hardingson's face, cross and worried, appeared at the window beside me. He said, "well?"

"It's all right," said Dave, before I could collect my wits. "A junior member of Maggie's organization getting nosy, that's all."

For a moment Hardingson's face went smooth with relief. Then a fresh frown started.

"It's all very well—"

"Let's get inside," I said hastily. "I'd better do something about lunch."

I found an assortment of beer cans in the fridge and left my guests to serve themselves while I put together a salad. That and bread-and-butter and some sliced ham and cheese would have to do. I kept an ear cocked towards the living room, but if they were arguing they were doing it quietly.

When I went to call them, Peter Hardingson was in the middle of a bitter oration.

". . . And the Recruiters, too. They're supposed to have their *own* organization in this Continuum, but one of them got the bright idea that they could use the Plaza for a mass operation—"

"How's that?" said Dave.

"Oh, they got together a great horde of youngsters of approximately the right age and tried to pick out suitable recruits through questionnaires and discussion groups. They did find two or three, but it gave them just as much work as the usual methods and involved us too."

"Ah," said Dave. "That's why the Plaza was licensed for public meetings, I suppose."

"What makes a suitable recruit?" I enquired.

"Intelligence," said Hardingson. "Stability under pressure. Age somewhere between eighteen and twenty-five. Lack of strong ties."

"Lack of prospects," said Dan.

"Unemployed orphans preferred?" I said. (So *that* was where Kevin's girl's sister's friend and a boy called Brian somethingorother had gone. I felt surprisingly relieved to have that explained. It was hardly something I could explain to Kevin, though.)

"In this immediate social context, I suppose so," said Hardingson. "In some place-times—"

"Tough sensible kids with nothing to keep them in this Universe," said Dave somberly. "That's what *they* think, anyway. Poor little sods."

"Rubbish," said Hardingson. "They gain immeasurably—"

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"You can't measure what they lose, either. Coming back here . . . Your own personal history, that's the first sacrifice. Can't afford it, you see, Maggie. In Elsewhere we're recruited from every national and racial and religious group, over about twelve centuries. Can't afford all those divisions if we're all to become citizens of the same Universe."

"No, we can't," said Hardingson sharply. "As for sacrifices, I personally have lost nothing that I regret. Nothing at all."

"Not now, maybe," said Dan. "Are you going to say you never cried yourself to sleep, during the first year in Elsewhere, or that you never felt one single solitary pang—"

"That'll do, Clarke." Hardingson stood up. "Naturally, the adjustment to completely strange surroundings is not wholly painless, for anybody, but it is unquestionably worth while. Good God, the chance to become the first settlers on a whole new world—quite apart from all the other gains—"

"Oh, the fringe benefits are tremendous," said Dave. "Don't look so worried, Maggie, it isn't the beer—I'm damned if I know what it is. Too many farewell parties. Too many farewells . . . Did you say lunch?"

It was not exactly a festive meal. My guests were inclined to brood, and I let them, since I was brooding myself.

The girl who told Kevin that there was "something going on behind the scenes" at that seminar had after all been perfectly correct; it was also true that Linda and Brian had very conclusively disappeared.

That particular source of difficulty could be dealt with; presumably Peter Hardingson could arrange that Linda and Brian send letters to anxious friends, with a suitable story to explain why there wouldn't be any more. It might be advisable to let him mellow a bit before asking him, but it would help to keep undesirable attention away from the old Plaza, so he'd see to it, no doubt.

But there was still tomorrow, and tomorrow, and tomorrow, right up to the convention and beyond. Plenty of time for Kevin's active, suspicious, inquiring mind to come up with something else. Moreover a good third of the guests at the convention were likely to belong to Kevin's age-group, and I was wondering just how dangerous all that youthful perceptiveness might be, let loose among the secrets of Thingummy Hall. ■

THIS IS PART OF THE SAME SERIES AS THE STORY, "THINGUMMY HALL," WHICH APPEARED IN THE JUNE 1988 ISSUE.

●I have never found, in a long experience of politics, that criticism is ever inhibited by ignorance.

Harold Macmillan

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Margaret L. Silbar

MYSTERIES OF LIGHT AND LIFE

Light and life have always been closely connected—but there appear to be more kinds of connections than previously suspected.

In the beginning, the Lord said, "*Let there be light.*" And the plants and the animals began to shine.

Genesis II, 1988

Without the photon, the quantum of the electromagnetic spectrum, life would not exist. We would neither see nor be, as the ultimate source of almost all the Earth's energy is the steady stream of photons coming to us from the Sun. The secret of life lies in the conversion of this light energy into chemical energy and hence, to food and fuelwood.

In addition to providing us with "power," most of the information carried around the universe is so done by photons. Cosmic photons tell us of the existence of far distant stars and quasars. Photons of longer wavelength dominate the information scene on Earth. Television, infrared photography and x-ray pictures, all are examples of transmission of information by photons. For instance, consider the antenna of a TV station. Its electrons are made to oscillate, emitting photons. Some of these strike the home receiver's antenna and are absorbed by its electrons. The resultant electronic motion is communicated by electrical signals to the interior of your TV set. Whence the next episode of life in "Dallas."

The range of the electromagnetic spectrum is enormous. At the low end it contains practically useful frequencies, such as those found in induction heaters, many miles in wave length. It continues up through the higher fre-

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quency waves of radio and TV, through the visible light spectrum and on into the very short wave lengths emitted by astronomical objects. Indeed, everything from an interstellar grain of sand to a deep-sea squid to a white dwarf emits some kind of light.

While all electromagnetic waves are qualitatively the same, their origins are often different. The light coming from the interstellar grain and from the white dwarf can be attributed to their temperatures. But what about the light in the night sea that seems to make it "burn"? Or the eerie glow from rotting logs deep in the forest? "It is of the nature of smooth things to shine in the dark," concluded Aristotle, giving us but two examples, "the heads of certain fishes and the juice of the cuttle fish." At first called *cold light*, we now know this as *bioluminescence*, a chemical phenomenon. The glowing gallery of living organisms includes everything from mushrooms to click beetles to jellyfish, clams and fireflies.

Amphibians, reptiles, birds and mammals do *not* shine, however. Or, do they? The first clue of a *spontaneous luminescence*, emitted by almost all cellular material, arose behind the Iron Curtain and took a long time to percolate to the west. Higher organisms shine by emitting ultra-weak streams of photons, so weak that they are invisible to the naked eye. Unlike ordinary bioluminescence, this spontaneous luminescence becomes more important as one moves up the evolutionary scale.

Indeed, it has recently been suggested that this kind of glowing may sometimes resemble that of the laser, that is, the photons may "line up" and transfer information coherently. If so, this might be the physical basis for the control of life in all its manifestations. At long last we may learn to discuss biology and physics in the same terms. Meantime, since the multiplicity of life forms—and the ways electromagnetism manifest themselves in various organisms—are all tied up with the question of how life itself began, we will return to speculate a bit about that toward the end of this article.

Not all that lives and glows is truly bioluminescent. If Artistotle's observation about the heads of fishes was based on a dead fish, it was no doubt not the fish itself, but the presence of the luminous bacteria it was harboring that was causing the light. Indeed saprophytic bacteria have been known to cause ham cured in salt to glow. In the 1940s, at least one Texan had a tall tale to tell upon arrival at the local police station, mystery meat glowing in his hand.

Bioluminescence is remarkable in its diversity and spottiness. Certain bacteria and mushrooms emit light continuously; the dinoflagellates, the algae that cause the poisonous "red tides" and the "burning of the sea," flash only when disturbed. Among animals, it casually appears in everything from unicellular radiolaria to such complicated vertebrates as sharks and bony fishes. No higher vertebrates, from shrews to giraffes, are bioluminescent.

The randomness, moreover, crosses family lines. One species may be luminescent but not a closely-related

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brother. One example is *Cypridina*. This marine crustacean, less than an eighth of an inch long, has two hinged valves covering its body. It is found in both fresh and salt water, but only the marine forms are luminescent. This brings us to another peculiarity, and that is the almost complete absence of luminous species in fresh water.

Bioluminescence is a special form of *chemiluminescence*. It does not come from nor does it depend on light absorbed by the organism. The chemicals are synthesized by living cells and the photoluminescent reaction is catalyzed by an enzyme. When it occurs, a slow oxidation or burning, like that of phosphorous, takes place.[1] Chemical energy becomes light energy.

The mechanism, whereby this occurs, first began to be understood in the last century when Raphael Dubois studied the luminous clam *Pholas dactylus*. In Greek *pholas* means "lurking in a hole" and indeed this mollusk habitually bores into soft rock and hides there. Dubois demonstrated that a cold-water extract of *Pholas* would continue to emit light for several minutes. After the glow ceased, it could be restored by adding a second non-luminous extract. This he obtained by washing a fresh clam in hot water and cooling the juice.

His conclusion? There is some substance in the second extract, necessary for light emission and unaffected by heat. This biochemical substance, he called *luciferin*, a name after *Lucifer*, or "light bearer." The substance in the cold-water extract he called *luciferase*. The suffix "-ase" indicates it has the properties of an enzyme, or biological catalyst.[2] Catalyzed by the enzyme, the luciferin undergoes oxidation. The resultant energy puts the product in a higher-energy excited state, which then decays by emitting photons.

The parent of the process is different in different organisms. Take *Cypridina*, which lives on the bottom of the sea and comes out to feed at night. It excretes luciferin and luciferase, each from a different organ, into the surrounding water and the interaction of the two substances produces blue light. The firefly squid, *Matasenia scintillans*, provides yet another example—it produces light by an intracellular chemical reaction, and we will return to this peculiar animal in a bit.

Meantime, there are the flashlight fishes. One species, *Photoblepharon*, lives in the Red Sea, the Pacific and Indian Oceans. It lights up the water with a large organ under each eye: hence, its family name, *Anomalopidae*, derived from the Greek, means "abnormal eye." These organs contain luminous living bacteria, which collectively generate as much light as would come from a weak flashlight.

In fact, the collective light of these fishes gave rise to a scare in the days after the Six Day War waged by the Arabs and Israelis in 1967. Patrolling the coastline of the Sinai Peninsula, Is-

1) The responsible substance is not phosphorous, as was believed long ago.

2) It is not simple; it apparently contains about 1,000 amino acid subunits.

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raeli soldiers observed a faint green glowing mass by a coral reef. Thinking they were about to come upon enemy frogmen, they detonated explosives. To their surprise, all they found was a beach littered with small dead flashlight fish whose heads continued to glow with a pair of green patches. The bacteria, of course, were still alive!

Because the reaction is a chemical one, a live organism isn't at all necessary. Japanese soldiers in the field used dried *Cypridina* for light during World War II. Crushing a few of the small marine crustaceans in the hand and moistening them with saliva gave a glow adequate to read a map, but not (as would a flashlight) sufficient to alert an enemy. Today, one can buy something called a *Cyalume light*. This stick gives off light for eight to twelve hours. "Just bend, snap, and shake," says the advertisement in the catalog.

Many bioluminescent organisms, like Cypridina and the flashlight fishes, emit a blue or green light. A few emit yellow light. Red is extremely rare. The first documented example of red luminescence was that from the head of the Central and South American beetle, *Phrixothrix*. This beetle is particularly unusual in that it is also one of the few creatures to luminesce in two colors. The larvae of these insects are decorated with two parallel rows of luminous green spots. On the head of the larva are two spots that glow red. When only these are showing at night, the animal looks like a glowing cigarette. If disturbed and crawling, however, the green lights flash on, giving it the appearance of a railroad train with red head lamps. Hence, it is commonly called "the railroad worm."

Recently, the first observation of any marine red luminescent system was reported. The suborbital light organs of two deep-sea fishes *(Aristostomias scintillans* and *Malacastens niger)* have been measured; the former had previously been seen flashing red, but no one had ever reported visually seeing light from the second species. It appears, however, they both fluoresce red when stimulated by ultraviolet light. The spectra were recorded at sea on freshly-trawled specimens.

In 1916 E. Newton Harvey had already established that the glow of the firefly resulted from the same luciferin-luciferase reaction that Dubois had found in the luminous clam. ATP, or *adenosine triphosphate*, is one of biology's most common energy-storing molecules. It can be thought of as the quick energy battery in the cell, and it is essential to the glow of fireflies.

The flash is triggered by a nerve impulse delivered to the luminous gland, which in turn sets off a chemical reaction that consumes luciferin and oxygen. The products are oxidized luciferin, two phosphate compounds: water and, of course, light.

Very recently, a second district example of luminescence that requires ATP has been reported. It is that of the firefly squid of Toyama, whose name in Japanese is *hotaru-ika*. In the spring, these self-luminous squid, come inshore from the deep sea by the billions to

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breed. While swimming, it emits brilliant flashes of blue light.

So-called spontaneous luminescence, or ultraweak photon emission, is *not* ordinary bioluminescence. Its intensity is many orders of magnitude less. And, the photon emission cannot seem to be suppressed by any known agent, chemical or physical. This phenomenon was first seen in the late 1920s when A.G. Gurwitsch carried out a series of experiments on onion roots. He discovered—though this was not his primary purpose—that various kinds of dividing cells luminesce weakly in the ultraviolet range.

He set out to examine the influence of rapidly dividing cells on others not undergoing division. Gurwitsch put an onion root into a glass tube with a metal cover. (This was to be his detector.) A hole in the tube uncovered one section of the root and, opposite this hole, he placed the end of a second tube containing another root. This second root, with its rapidly dividing cells, in no way touched the first. After several hours, the section of the detector root facing the inductor root also began to show an increased frequency of dividing cells. Since, in these first experiments, photons stimulated other cells to divide, the phenomena was first called *mitogenic radiation*. Refined experiments using mirrors and optical filters, made of glass and quartz glass, then lent credence to the hypothesis that, under certain circumstances, most biological tissues emit ultraviolet light.

Systematic investigation of ultra-weak photon emission was not, however, undertaken until the 1950s. The Italian L. Colli and his co-workers, apparently unaware of the earlier work of Gurwitsch, discovered a weak emission of light from germinating seedlings of some common plants. The impetus for their work was no doubt the development of photomultiplier tubes, which served as efficient counters of photons. These detectors are several orders of magnitude more sensitive than anything that had previously existed.

The Colli group studied the seedlings of wheat, beans, lentils and corn. To prevent any outside contamination, the seedlings were grown on glass plates and in darkness. These seedlings were found to emit quanta photons, at a rate that varied from 250 counts per second to 700 counts per second. Using control sterilized seedlings, they showed the photons were coming from the seedlings themselves and *not* from bioluminescent bacteria. Interestingly enough, seedlings cut into pieces radiate two or three times more than visible ones.

In the late 1960s scientists in the Soviet Union began to take a particular interest in this phenomenon. Soon, more than 90 species of plant and animal cells had been investigated, spanning the range from yeast cells to various parts of the anatomy of frogs and mice. All but a small number of algae, bacteria and protozoa *do* shine. Among the holdouts are cyanobacteria, the blue-green algae that learned to photosynthesize. They do not radiate this kind of photon.

To describe but two representative examples of ultraweak photon emission:

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a contracting frog heart emits light quanta at the rate of some ten counts a second. It does so, whether isolated or still in the thorax. Intriguingly, the sciatic nerve of a frog, when stimulated, emits light. But a dead nerve does not. This is in contrast to bioluminescent organisms. Recall the crushable crustacean, Cypridina, which continues to emit light, even in dried form.

What else distinguishes this spontaneous radiation from other types of radiation? Its intensity may be anywhere from a single to two thousand photons per square centimeter per second. As with bioluminescence, the photons emitted are found to spread over the electromagnetic spectrum. The emission of the plants is located in the blue-green range while animals seem to radiate in different ways, either in the blue-green or red parts of the spectrum. Proliferating cells radiate more photons than do those that grow no longer. Cancer cells are relatively intense radiation sources. Cells often die giving off a burst of photons. The cause of death is not important, whether it is by boiling, freezing, or an attack by chemicals.

One of the Russian groups discovered that different sorts of grain radiate their maximum number of photons at the exact temperature at which they are just able to survive. Animal tissue shows a similar effect. A mouse liver, cooled to three to four degrees centigrade, radiates in the ultraviolet and visible region for three to four minutes. The intensity later wanes or disappears completely. This has been taken as evidence that the genetic apparatus of the organism in question somehow influences the ultraweak photon emission. Unlike bioluminescence, no one has truly pinpointed the responsible mechanism. From whence cometh these photons?

This leads to several interesting questions, posed by Fritz Albert Popp of the Technologiezentrum in Kaiserslautern in West Germany: "Are photons being stored? Are there photon storage machines—perhaps in the DNA itself?" To investigate this, Popp and his colleagues have looked at human erythrocytes, or red blood corpuscles, which do not contain DNA. No photon emission was detected.

This has led Popp and a number of colleagues to postulate that biological systems generally have the capacity to store photons which come from the outside world, perhaps from the food supply. A hint can be derived from a number of natural processes, including glycolysis. Glucose, Popp points out, contains stored virtual photons[3] which have their origin in the sun. "Glycolysis can be looked upon as the liberation of these stored photons. The released photons may be stored again and reemitted, thereby regulating bioprocesses."

As organisms in a given taxon become more complex, so too does the amount of DNA they seem to need. Nonetheless, only a very small proportion of this DNA (that is, two percent

3) A virtual photon is one emitted and absorbed by two interacting electrons (or other charged particles) without ever having quite been "freed."

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or less) seems to operate as genetic material. Several authors have therefore suggested that all this DNA which does not code for proteins or stable RNA's is "selfish," "parasitic," or "junk" DNA. Popp argues against this view on the grounds that it is "very unlikely from an energy point of view that cells replicate and inherit so much unnecessary DNA." Popp thus argues for photon storage in the DNA as a possible purpose for this "junk" DNA. He envisions being able to explain biological oscillations, such as the circadian rhythm, by means of photons interacting in the DNA.

But back to the basic premise and experiment. If DNA is a photon storehouse, then as it unwinds it should release more photons. Indeed, experiments performed by Popp and his colleagues may indicate the validity of this. They started with cucumber cells and later moved on to soy bean cells, using the chemical called *ethidium bromide*. While ethidium bromide does not interact with other biomolecules, it does completely unwind the coils in DNA and then, as its concentration is increased, cause them to reform, albeit with their twists in opposite directions. The intensity of the photons emitted follows the structural changes of the DNA: it was highest at the concentrations where isolated DNA uncoils. (See Figure 1.)

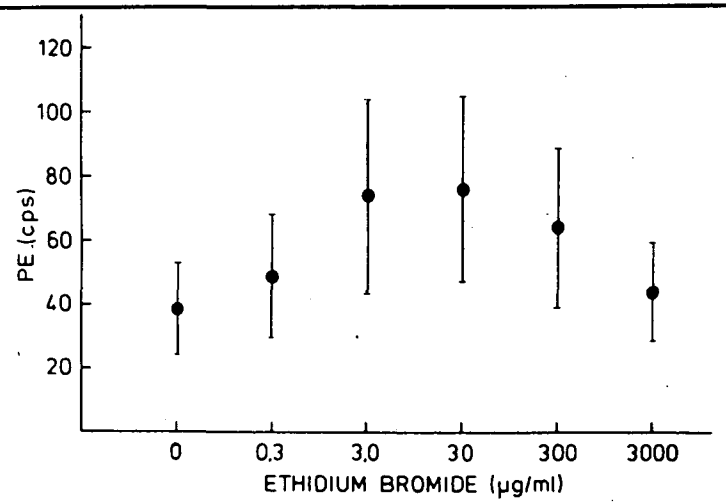

Figure 1: Can DNA store and emit photons? Investigations undertaken by Fritz A. Popp and his colleagues indicate it can. When, for example, soya cells were treated with various concentrations of a tracer molecule, ethidium bromide, biophotons were emmited at just those concentrations known to decondense, or unwind, the superhelical structures of DNA. The fact that the intensity of photons increases as the structure of the DNA changes is taken as evidence of stored photons. F.A. Popp, et al. "Biophoton Emission: New Evidence for Coherence and DNA as Source," *Cell Biophysics*, Vol. 6, 1984.

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This, says Popp, is a clear indication that DNA is "the essential source of ultraweak photon emission from biological systems." Not everyone would agree. "The hypothesis that DNA can work like a photon trap is based on rather indirect experimental evidence," says W.B. Chwirot of the Nicholas Copernicus University in Poland. "New experiments are necessary to verify the model."

That cells flash light to other cells had been suggested in an old, unconfirmed, and incredible report from Akademgorodok in the Soviet Union.[4] The team at the scientific center in Siberia reported finding that a normal cell emitted a steady output of photons, but when it was infected by a virus the radiation pattern changed sharply. When the Soviets infected a normal cell with a virus, the disease broke out almost immediately in neighboring cells separated from the infected ones by a quartz glass barrier. The researchers said they could never find any trace of the viruses in the newly-diseased cells. Nonetheless, they *were* infected, suggesting that living cells possess a radiation channel for the transmission of information.

A subtle type of long-range quantum mechanical order is found in masers and lasers. That is, their photons "line up," or are coherent. Why not also in biological systems? Ke-hsueh Li, of the Chinese Academy of Sciences, notes in a recent theoretical paper that the significance of stimulated and coherent effects in living systems ought not be underestimated. "In fact, the laser principle is not specific to non-living matter because it may be traced back ultimately to the detailed energy level structures of atoms and molecules," says Li. "This must naturally also include biological molecules."

To which Popp adds: "pattern recognition as, for example, repair mechanisms and immunity, might depend finally on the coherence of the photon field within the body." But *is* it coherent? Because the intensity of the emitted light is so low, investigations have been limited. Clues have been indirect and statistical, but this situation may be improving as studies using induced photon emission have begun.

To take but one example, that of Poland's Chwirot. He went out and collected intact male cones from larch trees, later analyzing fractions of them as they underwent meiosis, the process that results in cells with half the number of chromosomes present in the original cell. To make a long story short, these cells emitted light at eight of thirteen developmental stages investigated, indicating at least partial coherence. That is, a long-term "memory" (for lack of a better word) would seem to be indicated.

On the basis of this and work of his own, Popp has concluded that emitted photons are not governed by random and chaotic mechanisms. And, in fact, his conclusions are not inconsistent with a

4) I first read about this in 1973, in the January 25 issue of *New Scientist*. Despite a day spent in a fine technical library, I never found another paper that referred to it.

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rather different piece of evidence. It comes from the *coleoptiles* which sheath and protect the first-formed leaves of grass seedlings.

Studying the effects of light on these hollow sheaths, D.F. Mandoli and W.R. Briggs of the Carnegie Institution in Stanford, California, discovered that coleoptiles are capable of coherent transfer of light over at least 20 millimeters! The Californians applied light, such as that from a helium-neon laser, to one end of a curved dark-grown tissue segment, such as that from oats, or maize, or mung beans. The other end passed through an opaque holder and abutted onto the surface of a photomultiplier. Photographs show that light is piped through these etiolated tissues. These dark-grown tissues act as multiple bundles of optical fibres,[5] not as single internally reflecting structures. This coherence is yet another example of an unexpected, but fundamental property of light in living systems.

No one has ever been able to identify precisely that which separates the living from the non-living. The most one can probably say is that the difference between a live leopard and a dead log is in the information content, and the difference between a living and a dead leopard is in the availability or usability of that information. Yet, somehow in the transition from non-living to living, various organisms—probably first the bacteria—shared the secret recipe that allowed them "to be." This chapter in pre-history is shrouded in mystery. Indeed, the development from bacteria and blue-green algae to mice and men is far better understood than that of the first self-replicating entities. These, to survive and multiply, had to develop certain distinctive characteristics, perhaps even the ability to emit light.

There are lots of theories about how life itself began, but the specific details are missing. Even the little that is known is the subject of controversy. The modern version of Genesis gives us an early Earth with a messy atmosphere. Ultraviolet light from the sun and electrical sparks from lightning are presumed to have triggered chemical reactions among a mixture of simple gases—methane, ammonia, water vapor and hydrogen. Chemicals were formed, later to dissolve in the seas, giving rise there to a rich prebiotic broth. By happenstance (that is, by virtue of Natural Law), the broth birthed *something* which went forth with sufficient information to multiply fruitfully.

Problem number one with this scenario is that, while many laboratory experiments have taken place, they are in clean, controlled environments, and there is no reason to believe that the early Earth was anything but messy, turbulent and violent, rather different from today's quiet laboratories. To believe that the conditions in one echo those in the other strains the imagination.

Problem number two involves what it *was* that evolved to carry information out of the broth. The majority view is

5) It seems Ma Bell didn't get there first, although the development and application of optical fibres for long-distance communication is a technological triumph.

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that it was the nucleic acids, such as DNA and RNA, today the carriers of genetic information. Another view is that it was the proteins, another important contemporary class of biochemicals. It's all a bit circular. Nucleic acids are required to make proteins, whereas proteins are needed to make nucleic acids, which in turn are needed to encode proteins.

Take even the simplest nucleic acids or proteins. They are *very* complex types of molecules, which need to be of a considerable size to do anything useful. Proteins are made by joining 20 standard amino acids together in specific linear sequences while nucleic acids are formed in a similar way from four standard nucleotides.

"Even the simplest forms of life are so complicated that their spontaneous appearance in a mixture of prebiotic organic compounds would constitute a miracle," says Leslie E. Orgel of the Salk Institute. "We must conclude that contemporary cellular life was preceded by a series of systems of gradually increasing complexity."

Orgel recently set out, together with a colleague, Alan Schwarz, to explore the long-standing possibility that short-chain nucleic acids may have undergone inefficient self-reproduction without the help of enzymes. The two considered primeval "nucleic acids," different from the familiar RNA and DNA of modern cells in that the bases are separated by two phosphate groups. Ordinarily, there is but one. The experiments suggest that these unconventional structures form more easily under prebiotic conditions than conventional DNA or RNA, and that they will be at least as effective at replicating themselves without enzymes as more conventional molecules are.[6]

Life still hasn't been seen swimming out of a test tube. Nor has a perhaps more important problem been resolved, that of how information is made available to the replicating entity. This leads to the interesting question of whether photons could have had an early role in evolution beyond that of simply providing the energy. Popp, based on the ideas garnered from the mysterious phenomenon of spontaneous luminescence, speculates that the origin of the earliest life may have involved coherent radiation. Such coherent photons could perhaps have provided the mechanism for the orderly transfer of information in the days before the mechanism for DNA had evolved. "Stable structures of a small size are used to build up further structures governed by principles requiring maximum coherence," he suggests.

However self replication first arose, the mother broth was ultimately filled with the replicator's descendants. At that point Darwinian evolution is said to have taken over. Natural selection, according to Orgel, "is the only mechanism that could have generated a series of intermediate forms." And, from

6) The central dogma is today expanded, as there are now RNA viruses which can replicate themselves, retroviruses with their reverse transcription, and RNA phenotypes that are enzymes and can therefore catalyze reactions. But since the point is simply how complex the so-called "simple" explanations are, we will not wander further afield.

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those, the life forms we now know and love.

Natural selection involves three ingredients: a way to inherit successful recipes, a continuous intrusion of noise so as to allow variations (mutations) in offspring, and the competition for energy, for food and fuel. One early problem natural selection would have had to overcome is that of guiding living creatures through what Cyril Ponnamperuma, of the University of Maryland, has dramatically portrayed as an "hourglass." (See Figure 2)

In the beginning, the atmosphere was thought to be without free oxygen. The earliest identifiable life forms were anaerobic, primitive, unicellular microorganisms that lacked a distinct nucleus. Organisms went through much of their early development on this planet in the absence of oxygen, argued George Wald, in his now classic treatise on *The Origins of Life*. "It would otherwise be difficult to understand the ingenuity they have displayed in developing anaerobic pathways of metabolism."

In moving from an atmosphere without free oxygen[7] to one rich in oxygen, however, there must have been what

7) The original reducing atmosphere is thought to have contained large amounts of methane, hydrogen, ammonia and water vapor, the same mixture of gases with which Stanley L. Miller first demonstrated the synthesis of amino acids in the laboratory.

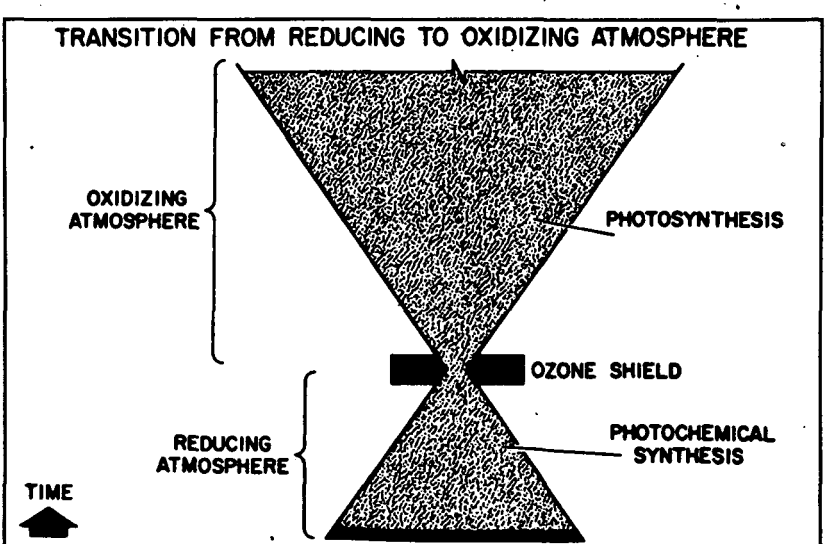

Figure 2: An hourglass? Cyril Ponnamperuma suggests the transition from anaerobic, primitive, unicellular microorganisms to the complex, multicellular, aerobic organisms we know today is catastrophic. Many would not have been able to successfully navigate the long thin neck of what he calls an "hourglass"; that is, it would not have been able to make the transition from a reducing to an oxidizing atmosphere. *Cosmochemistry and the Origin of Life,* edited by C. Ponnamperuma.

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Ponnameruma calls "a wholesale massacre of biota," as many organisms could not pass through the long, thin neck of the hourglass. The transition from a reducing to an oxidizing atmosphere would not have been rapid even by geological standards. "Until the cell had achieved a highly organized and protected state," Ponnamperuma says, "free atmospheric oxygen could not have been allowed. Its presence would have quickly oxidized the early precursors of life and absolutely prevented their evolution or even their existence." It is in trying to navigate this bottleneck that bioluminescence may first have appeared.

To backtrack a bit, blue-green algae can be thought of as "bacteria" that "discovered" the process of green-plant photosynthesis after the development of the atmosphere's ozone layer.[8] By shielding Earth from the ultraviolet light of the Sun, the ozone layer would have prevented any further photochemical synthesis of organic compounds in the primitive soup.

Unicellular and filamentous, the blue-green algae or cyanobacteria consume water, liberating free oxygen into the air. They are like bacteria in that they divide by fission, and they do not have their genetic material organized into a discrete nucleus. Blue-green algae are very efficient reproducers. It has been calculated that the offspring of one gram of such algae could produce (photosynthetically) an amount of oxygen equal to that of the present atmosphere in less than 40 days (assuming unlimited *Lebensraum* and nutrients).

The secret of photosynthesis is that it converts light energy to chemical energy. Chemists have known for many years the individual molecular components necessary to make the "machine" work. Until recently, however, no one could put together the pieces and recreate the primary natural function—that of a solar-powered elelctrolytic battery. The process occurs in a specific *reaction centre*.[9]

The crystallization of such a centre from algae,[10] in 1984, was considered one of the most exciting developments ever in the study of photosynthesis. Three years later, this *tour de force* was echoed as reaction centres were also isolated in plants and cyanobacteria. A voltage difference across a membrane drives the chemical stages of photosynthesis. The precise spatial relationships between the molecular entities responsible for the conversion of absorbed photons into this voltage difference have even been determined.

A remaining photosynthetic puzzle: the molecules involved seem to be rather widely separated. There is no evidence that they are connected by "wires" for

8) The ozone layer probably developed as oxygen, was released into the upper atmosphere by the photodissociation of water vapor by ultraviolet light.

9) British spelling is the standard here.

10) *Rhodopseudomonas viridis*, in case you're interested.

11) Once again, man is scooped by mother nature. Perhaps biological systems evolving billions of years ago incorporated into their lives quantum-mechanical devices we only thought of in this century.

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the electrons to flow through to make the chemical reactions go. As quantum mechanical tunneling[11] enables electrons to move across relatively large, atomic distances, it has now been suggested as a possible transport mechanism.

However they did it, the first widespread appearance of these primitive, but prolific, algae could well have signaled the onset of oxygenic conditions. Conceivably, organisms might have persisted indefinitely on an oxygen-free Earth. It may even be that multicellular, nucleated organisms existed in anaerobic times, but did not make it through the bottleneck. The first such creatures to depend on oxygen were probably the plankton—the buoyant creatures that float freely in the sea, courtesy of cells containing thousands of cylindrical structures filled with gas.

The selective advantage of adapting to oxygen is that it permits cellular respiration[12] and allows the economic absorption of energy. The effect of respiration is the combustion of organic molecules; the mechanism involved is the removal of hydrogen by creating water, H_2O. The "burning" of hydrogen is one of the most energetic of combustions. Ultimately, living organisms had to find an economic source of energy, if only to survive the dark.

All respiring organisms share a common problem: the oxygen which supports their lives is at the same time toxic to them. They must have a defense system against the presence of too much oxygen. The similarity between the lethality of oxygen and ionizing radiation led, in 1954, to a theory of oxygen toxicity, that postulates it is the very reactive free radicals that damage the fabric of living cells.

Bioluminescence may at first have been one line of defense. Chemically, it is the most efficient way of removing oxygen from a living system—that is, to reduce the oxygen to form water. The most likely reducing agents? Those organic compounds that were already part of the anaerobic system known as the hydrogen-transport process. When oxygen is converted to water by such compounds, enough energy is liberated to leave organic molecules in excited states. These then de-excite by emitting light in the form of quanta, i.e., photons.

The role of oxygen in bioluminescence has been demonstrated by suspending luminous bacteria in tubes. The idea is to aerate one tube continuously, leaving another unaerated for several minutes, allowing its light output to decline. A third tube, left alone for ten minutes, is then shaken vigorously to introduce fresh oxygen. For a brief period, it will shine even more brightly than the first two tubes.

Potentially, all organisms at this time were bioluminescent. Later, as some learned to regulate oxygen levels by other means—gills, lungs, whatever—the selective advantage of bioluminescence was lost. But since it had evolved, along

12) Respiration is the reverse of photosynthesis. It has been estimated that all the oxygen in the atmosphere passes through organisms—in by respiration and out by photosynthesis—every 2,000 years and that all the Earth's waters are decomposed and recomposed by photosynthesis and respiration every two million years.

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with the primitive hydrogen-transport process, the trait itself did not disappear from nature's bag of tricks.

"If the principle of natural selection is to be applied, it is necessary that the ability to luminesce be of some value to the organism," wrote Harvey, the pioneer in the field of bioluminescence, some years ago. He conceded it "impossible" to understand the use of light to bacteria, fungi, or dinoflagellates, which he described as "myriads of simple but luminous organisms floating about at the surface of the sea, blown hither and thither by the wind." He concluded that it is only when the animal becomes complicated and develops a definitive pattern of behavior that one can assign a "purpose" or biological value to the light.

For some, it is a mating signal. How better can a low-flying male firefly advertise his availability to a flashing female in the grass? Each species of firefly has a characteristic flash. In the temperate zone, recognition apparently depends on the time interval between the male flash and that of the female. It is not understood why, but certain species in Asia and the Pacific flash in unison. The social collective, no doubt.

Not only do male-female pairs of the flashlight fish communicate with each other, but these fish also "light-talk" to other members of the group, the groups sometimes having as many as 50 to 200 individual fish. Photoblepharon fish have also learned to use bioluminescence in their role as predators. In the sea over a reef, they may create a luminous area so intense that small organisms are attracted to it. On moonless or dark nights, the flashlight fish uses the light to see and capture the organisms upon which it is to feed. These fish also use their light to escape those who would prey upon them. They swim in a zigzag fashion with their light on during the zig and off during the zag. Not knowing which direction the fish took off in while zagging, it would take a very clever predator to track the fish down.

Communication, predation, self-defense—all are ways organisms independently learned to use bioluminescence. But why did mouse livers and all those other biological cells come to luminescence spontaneously, albeit ever so weakly and coherently? That's a good question, and maybe there's a Nobel Prize lurking around somewhere near the answer.

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●He who beats his sword into a plowshare usually ends up plowing for those who kept their swords.

Anonymous

submitted by G. Harry Stine

●With hindsight, nothing looks so simple as a Utopia that has become reality.

Wernher von Braun.

submitted by G. Harry Stine

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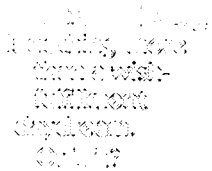

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"You ever wonder about luck?" he asked.

They were driving up the winding canyon road into the mountains, out for an afternoon drive and a walk in the woods and the chance to get away from town and time and people for a few hours. "Looking for meteorites," he called outings like these, because he'd always thought it would be neat to find one and he supposed that if he got out and walked around enough the odds would eventually work in his favor. Of course he didn't much like the prairie, which would have been a better place to look than in a forest with its steady accumulation of duff on the forest floor covering all but the freshest falls, but then meteorites weren't really the reason he went out walking anyway. They were just the excuse. By the time he got into the woods he had usually forgotten meteorites completely, and spent most of his time there looking up into the trees instead of down at the ground.

"What about luck?" she replied. She'd been looking out the window, watching the canyon walls slide past and wondering how many dinosaurs were buried in the sedimentary strata exposed by the road's construction, and whether the sudden boundary that she could see between colors of rock might be the 65 million-year-old Cretaceous-Tertiary boundary that marked the extinction of the dinosaurs. *They* certainly hadn't been lucky.

"I was just thinking how it seems sometimes that you and I are luckier than most people."

"What makes you think that?" she asked, but she asked it with a smile. Of course they were luckier than most. They had each other, didn't they?

He looked over and saw her smile, and they both laughed. He looked back to the road, shifted down and gave the car a little more gas going into the next curve. The smooth hum of the engine was like the car laughing with them. It was a '72 Datsun 240-Z, still in beautiful condition, and they'd bought it for a song when the previous owner—the one who'd done all the restoration—had thought the engine was about to blow. The problem had turned out to be a plugged fuel filter making it lurch and cough like a dying Pinto; they had replaced it with a two dollar and forty-nine cent generic filter from K-Mart and the car had run like a dream ever since. Yeah, they were lucky.

"So what got you thinking about luck?"

"Oh, I was putting the cooler in back before we left, and I'd left the hatch locked. Of course I forgot to bring the key with me. I was standing there with the cooler in my arms, wondering whether to just stuff it in through the front or if I should set it down and go back inside for the key, and I thought 'hey, wouldn't it be great if I hadn't slammed it hard enough when I closed it last time and I could just lift up the hatch?' So I gave a tug on the hatch and sure enough, it opened right up. That got me to wondering if it would've been unlatched if I hadn't thought about it first."

"How could that make any difference? It was either latched or it wasn't."

He grinned again and shook his head. "Maybe not. Quantum theorists believe that a subatomic particle doesn't nec-

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essarily have a 'true' state without an observer. It's just a probability wave until someone makes a measurement and collapses the wave into a certain state. Who's to say luck isn't the same way?''

She looked at him with head tilted. ''Quantum luck?''

''Right! We can call the particles 'luck-ons,' and—''

He waited until she'd quit laughing before he said, ''don't you wonder, though, how come so many things happen the way we hope they will?''

''Don't talk about it; you'll jinx it.''

''Hah. We're making a scientific examination into the nature of luck. Now just for a minute suppose that luck-ons are real. Every time you're in a situation that could go two ways, there's this immense probability wave hanging around. It doesn't collapse until you force it, in this case by tugging on the hatch to see if it's open or not. But if you imagine ahead of time a chain of events that could lead to the luckier of the two possible outcomes, then you bias the universe toward that side of the question, and then when you check it out that's the way the probability wave naturally collapses.''

''Uh huh.'' She wasn't buying it. But she could still appreciate the argument, so she said, ''I suppose that's what people mean when they talk about making their own luck. The power of positive thinking and all that.''

He knew when he was being ribbed, but if he'd let that sort of thing stop him he'd have been silenced on their first date. ''Exactly,'' he said. ''No doubt people have noticed it before, but until we discovered the actual operating principle it's been nothing more than a folk myth.''

He looked in the mirror and instinctively let off the gas, then sighed in relief as a police car with lights flashing sped past and skidded around the corner ahead.

They looked at one another for a moment before she said, ''let me guess; you saw him in the mirror and immediately hoped he was after someone else, right?''

''How'd you guess?''

''Luck.''

''Touché.''

Actually, an entire scenario had popped into his head in the millisecond or so that it took to recognize the cop car for what it was. He'd imagined an escaped convict parachuting out of a hijacked plane into the mountains somewhere up the road a ways, and the police heading up to try and catch him before he caught a ride out and away. The whole story was there, bang, in an instant. He didn't know where it had come from; random firing of synapses in a panicked brain, probably. He'd read that some people thought that that's all dreams were, too, just random impulses that the brain interpreted in ways it could understand. Whatever, it didn't matter. What mattered was that the cop was gone.

They broke out over the top of the ridge and there, stretched out in the valley below them, was the river. The road angled down until they were in the valley floor alongside it, driving through the aspens and cottonwoods along the bank. The trees were mostly bare, but what few leaves remained were still brilliant yellow and orange. The river was

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running low and clear, clearer than they'd seen it all summer, with pools of slow-moving water like a giant's footprints leading upstream as far as they could see.

"God I wish I'd brought the fishing poles," he said.

"I thought we were looking for meteorites today."

"You can look for meteorites in a fishing stream, too."

"True." She twisted around in her seat and began digging under the coats they had brought along in case the weather turned chilly, saying, "of course, you could have forgotten to take them *out* of the car last time we went fishing."

He glanced over at her, about to tell her not to bother looking, but an approaching car distracted him for a moment, and before he could say anything she exclaimed, "hey, what do you know, you did!"

"*What?*"

"You did forget to put them away. They're right here." She rattled the rods together to prove it.

He felt his heart give a twist in his chest, and suddenly it was pounding like crazy. He searched frantically for a pull-off, saw one coming up on the other side of the road, and braked hard, skidding into it and bringing the car to rest sideways.

"Hey!" She picked herself up out of the footwell. "What the hell was that all about?"

He had to take a couple of deep breaths before he could say, "I did too put them away."

She gave him a look that said clear as words, "you've blown a seam somewhere, bucko." But she didn't say it. She just reached back behind the seats and pulled out one of the three-foot sections of bamboo fishing pole.

"That doesn't make a bit of difference," he said, still struggling for control. "I remember putting them away not twenty minutes ago."

"Huh?"

"They were rolling around loose back there when I went to put the cooler in, so I gathered them up and put them on the workbench because I didn't want them rubbing on the Styrofoam and squeaking all the way up here. I remember doing that!"

She looked down at the pole in her hands, back up at him again. Her grin was a bit shaky as she said, "want me to toss them out?"

There could have been no better thing to say at that moment. Under the force of her smile, the anger that had suddenly welled up in him, the fear; both went wherever laps go when you stand up.

"I love you," he said simply, meaning it.

"I love you too. Shall we go fishing?"

"I don't think I could handle it right now. I did put those poles away. I *swear* I did."

"Then how did they get here?"

After a moment he said, "you wished them here."

Another police car hove into sight back the way they had come, swished past with lights ablaze, and was gone, leaves fluttering along the road in its wake.

"I *still* don't buy it."

They were driving on up the canyon,

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the fishing poles back under the coats, but not forgotten.

"I don't know what else to say. I remember taking them out of the car. That memory is clear as can be."

"You think there's another pair of fishing poles back home in the garage, then?"

Instead of answering, he took a sip of the Coke she had taken from the cooler. He set the can back in its niche in the console between the seats, then with a sigh, said, "no, that'd be asking too much. Conservation of mass wouldn't allow it."

"But you would?"

He shrugged. "Love, I *remember* what I did. I *did* put them away. But you didn't know about it, so when you went to look for them in back you found them." Slowly, the first smile he'd smiled in minutes spread across his face, and he went on: "or to put it differently, your luckiness collapsed the luck-on probability wave in your favor without regard for what I'd already done."

"So we're back to luck-ons, are we?"

"It's an explanation."

"And I suppose you'll drag out the multiple-universe theory to explain how you could remember it happening another way, right?" She was kidding, but there was an undercurrent of concern in her voice. They brainstormed together on wild ideas all the time, but never before had he gotten so . . . intense . . . about it.

"The multiple-universe theory?" he asked, his mind still not up to speed yet after his shock.

"You know. The universe splits off with every decision, so everything actually happens both ways."

"Oh, sure. Yeah, now that you mention it; it makes sense. When you collapsed the fishing pole luck-on you made a universe where I *didn't* take the poles out of the car, and somehow I wound up in the wrong universe."

"Thanks."

"Sorry. I didn't mean it that way. Just that in the other universe there must be another me who *did* put them in the car, and he and I somehow got our universes crossed."

She laughed suddenly. "And over there you and I are having a conversation just like this one, only you're saying, 'but I *did* leave them in the car!' and I'm saying, 'then where are they now?' "

He laughed with her, took another sip of pop, then said, "if that sort of thing happens very often, that could explain a lot."

"A lot of what?"

"A lot of arguments we get into about whose memory is right. Stuff like whether or not you told me you had to work Saturday, or what day we saw *Slaughterhouse Five* for the first time, or—"

"I haven't seen *Slaughterhouse Five*, and neither have you. We've been wanting to for years and we've never gotten around to it."

"Exactly. But I remember last month suggesting we go rent it, and you said you'd already seen it. We got in quite an argument about it. You even described some of the scenes to me."

"We didn't either have an argument about—did we?"

"I did. Evidently you didn't."

"How can that be? Why didn't you

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stay in the universe where we had the argument, if that's the way you remember it?"

"I don't know. Maybe we're attracted to each other." He poked her playfully in the ribs.

"Yeow! You think so, do you?"

"Oh, maybe a little. Just enough to keep us together even when the universes keep splitting us up." He whacked the steering wheel in excitement. "Yeah! Look, everybody in the universe but you is a robot, right?"

"Huh?"

"It's called solipsism. A solipsist believes that only he or she is real, that the rest of the universe is there merely to stimulate the self. The most powerful argument for solipsism is that it *feels* that way, that almost everybody already believes it deep down. You know everybody else is mortal, but you can't believe it about yourself; that sort of thing. Okay, suppose that's right, but in every universe, a *different person* is real. You're only real in one universe, and in all the other ones, the ones created every time something could go two ways, it's just echoes of yourself going through the motions for somebody else's benefit."

"So how does that—?"

"You and I are attracted to each other. Really. We're both real, here, in the same universe. And when the dividing universes split us up, we find our way back together. Maybe they naturally merge if there's not too much difference between the two, or—"

"Whoa, stop, wait a minute." She picked up the can of pop and took a long drink. "Look, this is all silly speculation. Luck-ons and multiple universes and arguments we didn't have. I don't believe it for a minute. I don't *want* to believe it."

"Why not?"

"Because if it's true, then we could get separated. We *do* get separated. And I don't know how to get back to you."

"But we do get back! That's the beauty of it. We're like magnets. We attract each other clear across multiple universes. All for the price of a few faulty memories."

They were driving through deep forest now. She looked away, watching the trees stream past, a blur of green, imagining each one a universe into which she could tumble.

"You're right, though," he said. "It's all speculation. We should experiment."

"No!"

"We can be careful. If we wish for something together, we'll both stay on the same side of the collapsing luck-on event. And then we'll know whether we can control it or not. It doesn't even need to be something all that unlikely. Like, there are lots of moose around here; we can wish for a moose out in the river when we come around the next corner. OK?"

"You don't give me much choice. You've already wished for it." And now she found herself wishing for it too. Wishing for a great, big moose with a rack of horns just as big as whatever *he* had wished for, standing however *he* imagined it standing. As they approached the corner she reached out and grasped his hand, squeezing hard. *Be there, be there, be there, be—*

"Son of a bitch," he said quietly.

A moose stood, big and black and

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real as ever, knee deep in the water, eating the grass along the bank. It eyed them dubiously as they passed.

"Quick, when did we see *Slaughterhouse Five?*"

"We didn't."

"Right. Are the fishing poles still there?"

"I don't want to look."

"I won't let go."

He couldn't have if he'd wanted to. She was gripping him as if her life depended on it, and she didn't think she'd ever let go of him again. But she twisted around and looked under the coats one-handed, and the poles were still there.

"Still there," she said. "So now what?"

"Once could be coincidence. We need another test to raise the odds against it happening by chance. If we can do it twice in a row, we'll know it's for real." He felt her tense even more, and added, "the better we understand it, the more control we'll have over it."

She knew he was right. Now that they were this far, there was no turning back. "So what do we wish for this time?" she asked.

"How about something different? Something we normally wouldn't want to see, like a beer can in the road. Just to test if we can control which fork in the path we take, or if it's always the lucky path. OK?"

"OK, a beer can in the road."

"Uncrushed," he added. "Just to make it less probable."

"OK."

They were already going around a curve; she tried to imagine a beer can standing on the center line just beyond where it straightened out again. She got an image in her mind, and seconds later image and reality were the same. There it stood, tall, rectangular, shining blue and white and gold in the sunlight, almost twice the size of a regular can. . . .

"A *Foster's* can?" he asked incredulously.

"Well, you said you wanted improbable."

"Ha, so I did." He flipped on the emergency flashers and began to brake to a stop.

"What're you doing?"

"Picking up our litter. After all, we did put it there." He stopped the car, opened the door, and picked up the can. He looked it over carefully, then said, "Looks like a Foster's can to me."

He held it out to her. She reached out with her right hand and took it from him, her left still holding on to his right. It certainly did look like a Foster's can, all right, right down to the improbably small flip-top hole on top. But where had it come from? Had their wish forced someone else to stop and set it on the road when they normally wouldn't have?

"You know," she said quietly, "this is what we get for subscribing to all those science magazines. We know just enough to be dangerous."

"I've got to find me a bush to hide behind," he said. They were driving slowly now, the road twisting and winding and switching back on itself as they neared the top of the mountain.

"I could use one too." She shook the empty Coke can, then tossed it behind the seat to join the Foster's can. It wasn't just the pop, though, she thought. This whole business with wishing themselves along different branches in the

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universe had scared it right out of her. They were playing with dynamite here, worse, and it didn't take a whole lot of foresight to see that they could screw up bad if they weren't careful.

"Hah, I can do better than a bush for you," he said. "There's a campground just ahead." He slowed down and turned off onto the gravel campground road, the car bouncing over the potholes until he got it into first gear and slowed to a crawl. They drove along beneath the trees, passing pullouts and picnic tables and fire grates, until they came to an outhouse. He stopped the car and said, "Go ahead. I'll park over there by the creek and just use a bush. There's nobody around."

She hesitated, not wanting to let go his hand, certainly not wanting to let him out of her sight, but she realized that unless they wanted to change their bathroom habits there were going to *have* to be times when they were apart. She nodded. "Don't make any wishes while I'm gone," she said, and she got out of the car.

The stream was even lower up here than it had been below. As he stood a few feet back on the bank, zipping his pants back up, he looked out into the pool where the main channel swirled around a good-sized boulder, trying to spot the fish that he knew had to be in there. He was careful not to *wish* for any fish, but if there were any there, he wouldn't mind seeing one.

He heard footsteps crunching on gravel and he thought, "Good grief, she was fast," but when he turned around he saw that it wasn't her after all. It was a tall, heavily-built man wearing some sort of loose gray coverall, carrying what looked like a Saturday Night Special in his shaking hand. The man's feet and legs were wet, as if he'd forded the stream.

"Get in the car," the man said. "You drive."

He looked up past the other and saw the outhouse door beginning to open. He couldn't make himself speak, not with the gun pointing at him, but he managed to nod, turn, and walk around the front of the car, keeping the gunman's eyes away from the outhouse, then open his own door and get in. The gunman got in the passenger side and held the gun to his head. "We're going to town. You drive real calm and normal like, and you live longer. Got that?"

"Got it," he managed to say.

"Let's go."

He started the car and put it in gear. In the rearview mirror he could see her running toward the car, shouting, and he tried not to think how she must feel as he let out the clutch and pulled out onto the gravel road again. He accelerated, got it in second, not caring about the potholes, only wanting to get this nut with the gun away from her, because he knew who the guy was. This was his escaped convict, the one the cops were hurrying up into the mountains to catch before he caught a ride out and away. He had *wished* this guy here.

Well he'd just have to wish him back out, first chance he got. He ought to be able to manage a sharp turn and a loose door, or something similar. He almost smiled at the thought, but then he realized what that would mean. If he wished this guy gone, without her beside him when he did it, would she still

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follow him down the right branch when the universe split? *Were* they magnets, always returning to one another even if they were separated? That was all speculation. And even if it were true, how big a change in the universe could he make before they got too far apart to attract each other again?

Damn! He'd reacted instantly, wanting to keep her out of danger, when what he should have done was wait for her to show up and then held her hand while the two of them wished for a tree to fall over on the guy. Now he was getting farther away by the second, and farther from including her in any plan he could come up with.

The outhouse was dark, as outhouses in the trees usually are. She expected to hear flies buzzing around inside, but it was eerily silent. Not until she'd sat down and looked up in the corner over the door did she see the reason for the silence: an enormous spider web dotted with the trussed-up corpses of the outhouse's aerial occupants.

Where was the spider? Let's hope it's in some innocuous corner, she thought. She began to look along the walls, then, suddenly realizing what she was about to do, she squeezed her eyes tight and covered them with her hands for good measure. Don't look! she told herself. If you don't look, you can't collapse the probability wave one way or the other.

She heard the car crunching gravel as he drove off, then the engine shut off and there was silence, broken only by the rush of the stream. She heard his door close.

Then, light as a spider landing on bare skin, she felt something touch her knee.

The universe seemed to shatter into fragments in that moment, and her with it. Part of her wished with all its might that the spider would crawl *away*, down her leg and out the door. Another part wanted no spider at all, but a stray bit of leaf or a pine needle instead. It could be; after all, she hadn't *seen* it yet. Still another part of her wanted only to scream, not in terror but in frustration, because another part, the dominant part, insisted on wanting nothing at all. *Let whatever happens happen*, she told herself, and with that decision made, the shattered pieces became whole once more.

She opened her eyes. The spider was as fat, as hairy, as ugly as she had feared, and it wasn't budging. She reached out and flicked it off her knee. That, at least, required no wish.

Pointedly ignoring the spider, she finished what she'd set out to do, pulled her pants back up again, and opened the door. She heard the car door open and close again, and when she looked toward the car she saw the man with the gun. For a moment she couldn't move, even to take a breath, and then it was too late to shout a warning, throw a rock, or anything else. The man climbed in the car, slammed the door, and the engine started.

She ran down the road toward the car anyway, shouting for them to stop, but he put it in gear and drove away before she could get there. She knew why he did it, but she still howled in frustration as she stood in the middle of the road and watched the car bounce its way out to the highway, then accelerate back toward town.

Now what? she thought as the dust

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settled. She leaned up against a tree for support, the craggy bark rough against her fingers. What do I do? Wish for a cop? There's at least two of them up here.

She tried to think it out. If she wished for anything, then she would likely wind up in a different universe than the one he was in. And despite his talk about being attracted to one another, she had no way of knowing if she could find her way back to him.

OK, then. It was better to wait it out, not do anything, and hope that he managed to get away from the kidnapper. She supposed it would be safe to wish for that, since her wish involved him directly.

But what if he didn't get away? What if the kidnapper . . . well, what if he killed him? What if this universe, the one she was in right now, was a universe in which her husband got killed? *He* wouldn't die; he'd live on in a universe where the gun misfired, or where the kidnapper didn't even pull the trigger, but she would still be here with a dead husband. A dead *copy* of a husband, but somehow she didn't think any amount of wishing would bring them back together after that.

What then? Should she wish for something after all? Cast herself adrift in the universes and hope to meet him again somewhere else, sometime on down the line?

What would he do? He's got a man with a gun in the car, and he knows he can wish him away if he wants to; what would he do?

He'd try to decide what she would do. He wasn't in any danger, not from his point of view. The "real" him would never find himself in a universe where he died. He would get out of it somehow. So he'd try to decide what she would do, and he'd act accordingly.

Well then, what should she do? From her viewpoint, the chances of him dying were greatest right here, if she did nothing. So doing nothing was out. Make a little wish, and thus just a little change? That seemed to imply a little change in his fate, too. No, what it came down to was a large change, a jump well away from the universe they were in now. Something *very* improbable, then, to match the very improbable something that would get him out of trouble.

What, though? What should she wish for?

In the car, his thoughts spiraled round and round the same subject. The kidnapper still held the gun on him, though in his left hand now and not all that threateningly. He seemed to be more concerned with squeezing as much heat out of the heater as he could get. He was shivering all over.

"Must be cold up there under a parachute, huh?"

"Don't talk, just drive."

He didn't like being told that at all. The way he figured it, the guy didn't want him to talk because he planned on killing him once he warmed up enough to drive the car himself. The less the kidnapper knew about his victim, the easier it would be to pull the trigger.

He was going to have to do something, and he was going to have to do it soon, before the guy warmed up. The easiest something would be to wish for the heater to break, he supposed. Or

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maybe for the whole car to break down. The guy wouldn't kill him if he couldn't get away from the body, would he?

He didn't want to find out. What he wanted was a *sure* way out of this mess, which meant a radical change. It had to be something plausible, something he could imagine happening so his belief in it could bias the probability wave toward collapsing in his favor, but it had to be unlikely. The likely thing in *this* universe was for him to wind up dead.

What, though? And would she realize what he had to do, and do something comparable? He tried to separate himself from his situation and see it from her viewpoint. She'd been afraid of getting separated; that was foremost in her mind. But she wasn't particularly religious. Surely she'd decide that death was about the biggest separation they could face.

The rest of the chain clicked into place. It wasn't hard to guess; they had always thought alike. Yes, she would know what he had to do, and what she had to do as well.

He turned his attention back to the kidnapper. The guy didn't look any warmer at all. In fact, his face looked as gray as a cloudy day, and now he was having trouble breathing, too. In fact, it looked as if he was having a heart attack.

A heart attack? a tiny voice asked, incredulous. A heart attack? Well, it could happen. The guy's been under stress, that's for sure, and he's got to be at least forty, and probably not in all that good a shape if he's been in prison for long. He's cold as ice, and probably had to walk at least a mile through the trees before he got to the campground, plus he's—

He stopped trying to convince himself. He didn't need any more convincing. The kidnapper was convincing enough on his own. The gun had slipped from his numb fingers and he clutched at his chest with his right hand, then slumped forward and struck his head on the dash.

There was a pull-off coming up on the right side of the road. He swung the car into it, reached across the kidnapper's lap and opened his door, planted a foot against his side, and shoved him out onto the ground. He opened the glove box and took out a pen, slid it into the gun barrel, and flipped the gun out on top of the body. Then he slammed the door, spun the car around, and headed back toward the campground.

Let her still be there, he thought. Let her still be there.

She was close to despair. She'd made her wish, imagined it in her mind a half dozen times until she believed with all her might that it could really happen, but nothing had happened. She walked along the campground road, her head bowed to the ground, looking carefully at every rock lest she miss the one important one, but it was all gravel there. Damn! She should have imagined it in the woods, where there weren't so many other rocks to worry about. But it was too late for that; she had imagined it this way, and she didn't want to change the scene in mid-wish. She had to stick with it, and she had to *believe* in it, force the probability wave to follow her will. She had to—

A flicker of motion out of the corner

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of her eye caught her attention. Something bright, high up in the sky. It winked out even as she turned toward it, and for long seconds she waited for something more, but nothing happened. She looked down to the road again, discouraged, just as the sharp Crack! of stone hitting stone reached her ears. Immediately after, the sonic boom from above finally rolled over her as well. About a hundred yards up the road, a black rock bounced and rolled to a stop amid the gravel, and as she walked, then broke into a run toward it, she smelled the scorched smell of her improbable wish drifting out to meet her.

It was a tiny lump of iron, about the size of a baby's fist. She stood over it, wondering if she should pick it up, when she heard the familiar sound of the car turning in off the highway. She watched it come along under the trees and pull to a stop beside her. He climbed out, reaching for her, holding her as if he never wanted to let go.

"Are you really here?" he asked. "Is it really you?"

"The one and only." She nodded toward the ground at their feet. "And look, I've found one!" ■

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on gaming

Matthew J. Costello

Licensing has become an increasingly dominant force in gaming. The logic of it, pretty obviously, is that if the source of the license—the book, the movie, the comic book or whatever—does well, it can only help a game to be successful.

Bill Battista and I have seen games based on everything from the hit black-and white-comic book series *Teenage Mutant Ninja Turtles* to one of the champ licenses of all time, *Star Wars*.

So we were not too surprised to get a call some months back from Eric Goldberg about a licensed game. Eric and Greg Costikyan had, in partnership with TOR Books, acquired board game and role-playing game rights to an upcoming movie, called *Willow*.

Now *Willow* was, at the time, a hush-hush project from George Lucas. It was to be nothing less than a grand epic fantasy, directed by Ron Howard, of *Cocoon* fame.

By the time you read this article, it will have become clear whether *Willow* turned out to be the phenomenal hit that many fans and professionals hoped it would be.

But, with Eric and Greg's help, we have been able to watch the development of the *Willow* board game, playtest it, and sort of get an intriguing view of the gestation of a major game.

It started, designer Greg Costikyan told us, with "a couple of objectives. I wanted a game that was simple enough to appeal to a wide market yet sophisticated to be a game that I like."

Greg's experience included designing and developing an esteemed body of games, including *Star Wars*, the role-playing game, the award-winning game, *Paranoia*, and one of my idiosyncratic favorites, *Bug-Eyed Monsters*.

He also said that it was important to him for the game to be, "in some sense a simulation of the movie . . . not an abstract game." As might be expected, the design process wasn't without its problems. "The first design I threw out entirely. Then, the next design wasn't sufficiently interactive. While there were cards, there was no playing of cards."

This playing of cards, using them against other players and helping to make your own position more powerful became a key feature of the boardgame.

During the design, Greg and Eric were working from assorted sneak peeks at the story of *Willow*. Willow, and the other good players in the game, must try to keep Elora Danan, a very special baby, out of the clutches of the evil Queen Bavmorda. The Evil players must try to find the baby, capture her and bring her to Nockmaar Castle.

When we first saw *Willow* it was being play-tested, with a number of refinements still to come. A colorful board had been created depicting Nockmaar Castle, Nelwyn Village, Fin Raziel's

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SENSE OF DIRECTION

Lyn Murray

The solution to a problem often depends on looking at it the right way— but how well you can do that depends on where you are.

William R. Warren, Jr.

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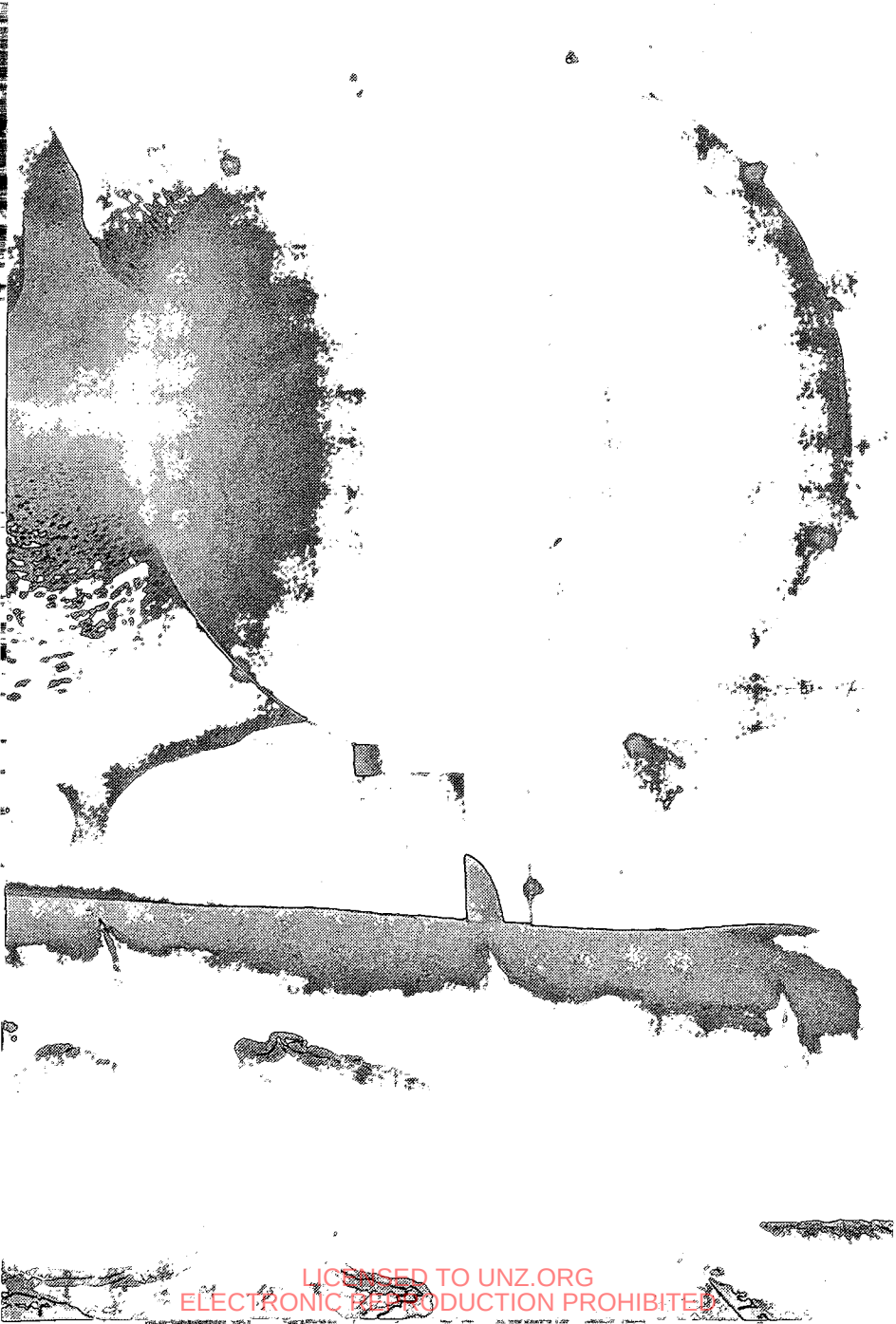

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In the depths of space, far from any star, the sphere floated in blackness. With no nearby reference point, it would have been hard for any outside observer to determine its size, or whether it was moving. Such an observer would, however, have noted the twelve smooth bulges, symmetrically placed about the surface of the sphere, and the network of lines connecting them. Along one of the lines, a vehicle moved, seemingly with painful slowness. At another point on the sphere, far from any bulge or track, a machine seemed to be busy about some incomprehensible task. But, of course, there was no intelligent being around to notice any of this, far from any star.

It was unreasonably hot, for the time of day. The sun beat straight down on Rantor's head from the zenith with scarcely any protecting cloud layer, even though it would soon be night. Pausing in his purposeful march to the shipyard he pulled a large kerchief from the leather pouch on his belt and mopped first his forehead and then the back of his neck. Wadding the cloth in his right hand as he prepared to put it away, he glanced up at the four flagpoles on the high tower of the castle at the head of the bay. Sure enough, three of the poles were bare, while on the fourth, a single flag flapped limply at half-mast in the unusually weak sea breeze. More than halfway through the fourth quarter; dark in less than two candles. And hardly a cloud overhead. Freak winds. Nothing to worry about, just one of those things. But where would a sailor be if he couldn't depend on the sea breeze by day and the land breeze by night?

Rantor shivered at the thought, in spite of the heat. The reliable winds provided the only sure means of navigation around the Archipelago. Which was why it was worth following up any lead that might provide a means to navigate beyond the Archipelago, out in the broad ocean. Even a lead as half-baked as the mission he was now on. Once again, he stepped out briskly towards the yard, the small shadow cast by the almost unbearably bright pinpoint of light overhead flickering beneath him as he strode along.

It had begun several fivedays before, with a summons from his Lord Kyper, the most powerful man in the Three Islands, perhaps the most powerful in the entire Archipelago, though that was not to say that the concerted efforts of three or more of his rivals might not bring about his embarrassment. Which was why so much of Lord Kyper's resources were devoted to ensuring that it never occured to those rivals to work in union against him—and why most of the rest of those resources were spent in seeking ways to consolidate his own position. Since Kyper was no fool, that meant that most of the inhabitants of the Three Islands were well cared for, and that their Lord's justice, while swift, was also accurate. To be in the service of Kyper himself was as much as any mortal inhabitant of the Archipelago could hope for. But even the most loyal and trusted servant, the Navigator himself, still felt a frisson of fear at any sudden summons from the castle.

The greeting had, however, been cordial enough, with just the minimum of formality that protocol required in the

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presence of a third party. A stranger to Rantor, and an outlander as well by the cut of his clothes.

"Well, Navigator." The duke seemed pleased, and reinforced his greetings with a brotherly embrace, both hands gripping Rantor's shoulders, not just the right as courtesy demanded. Kyper was still an impressive figure—fit, though slightly overweight, with just a touch of grey at the temples and speckling the black of his beard.

"I have a new fool, as you can see." His left hand swept out to indicate the odd-looking figure, while his right hand slid naturally across Rantor's shoulder. The stranger could have been left in no doubt that Rantor was the duke's most trusted aide and companion—which was certainly news to Rantor. But if this was the way my Lord Kyper wanted to play the scene, then so be it.

"Indeed? He seems none too amusing to me."

"Ah, but this fool's appearance is deceptive. He looks ordinary enough. But he has ambition. To sail to the edge of the world."

Rantor looked more closely at the little man. A lunatic? There must be more to this story than that, or the duke would not be taking this personal interest. Rantor had no illusions about his supposed friendship with Lord Kyper, but the duke knew the value of a good navigator, and wouldn't waste time with idle jests.

The man was clearly nervous, but not overawed by his surroundings. He seemed determined enough in spite of his slight stoop and forward-tilted head. He looked sharply at the two of them, almost like a cat sizing up a rival.

"My Lord." He spoke softly, but firmly, like a patient tutor with a difficult child.

"I know that you like to jest. But your guest may not appreciate the joke. If this is your famous navigator, please do not make him think that I am an idiot. I do not seek to find the edge of the world. I merely suggested that there must be an edge."

Startled by the discourteous way in which the stranger treated the duke as an equal, Rantor looked to Lord Kyper for guidance. The duke half-smiled, and raised an eyebrow. Clearly, madman or fool, the stranger was being given as much license as an official jester. But—the edge of the world? There lay madness indeed, since every schoolboy knew that the world beyond the Archipelago was infinite and unchanging, a flat ocean that spread equally in all directions.

The duke spoke, moving aside to a table as he did so. "This disrespectful outlander is called Hawk. Not for his physical attributes, you understand, but because, like a soaring bird he sees further than the rest. I have evidence of his peculiar skills, or he would not be with us now." He turned to the stooping man. Yes, thought Rantor, his eye is more like that of an eagle or a hawk than a cat.

"And this, my friend Hawk," the ironic emphasis on the word friend could not be mistaken, "is indeed Rantor, the greatest navigator in the Three Islands, and doubtless therefore the best in all the Archipelago. Convince him that there is more than madness in your schemes and my patronage is assured."

Hawk's manner changed, becoming

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politely more subservient as he turned his attentions to the navigator. Rantor realized that this came hard to the small man, who clearly was not used to pretending subservience to anyone. He must care deeply about the need to enlist the navigator in his cause; Rantor was more impressed by this than by the words themselves.

"Navigator, I apologize for my rudeness. I come from a far island, and I am not used to civilized ways. Also I have spent a long time, and much effort, to reach the ear of the only man who can help me fulfill my dream." Did he mean the duke? Or himself? Rantor pondered. The duke was all powerful here. Yet if the Hawk wished to venture out into the wide ocean, even the duke could not help him without the navigator's approval. . . .

"It is true, I believe—for very good reasons, I assure you—that our world is finite. But I also believe there is more to our world than an Archipelago."

Ah! the many worlds heresy. That explained the interest of the duke—and why there were no observers present at the meeting.

"But surely, Hawk, we are taught that there is only one Archipelago, set by God in the midst of the eternal ocean. If our Lord were not so generously disposed to his guests, you could find yourself in some discomfort for voicing such heresies."

The duke smiled. "All are free to speak their minds in my domain, Navigator, as well you know." And the duke's domain extended, as Rantor also well knew, only as far as the rule of his arms and the loyalty of his followers. There were priests who ostensibly owed allegiance to the duke, but who would undoubtedly take action against an outspoken heretic, especially an outlander. Even Lord Kyper lacked the power to change the laws on religious matters, in the face of a church which might be subservient in the administration of the Three Islands, but which extended its tentacles throughout the Archipelago, and didn't lack for fanatical followers. It was a wonder this fellow had lived to find his way to the comparative freedom of the Duke's realm.

"My Lord Kyper is indeed a generous host, as well as one possessed of a distinctive sense of humor. He is also aware, Navigator, that if there is any truth in these heresies, then somebody stands to benefit by it. I have no interest in wealth for myself. As a means to an end, of course, I appreciate its value. But my interest lies in finding out new things, questioning old beliefs, and investigating the world in which we live with an open mind. A navigator such as yourself, whose fame has spread across the Archipelago, must surely share some of those feelings."

"Perhaps." He looked to the duke for approval, and took his slight nod as encouragement to continue.

"I have sailed out of sight of even the farthest islands, and I have seen floating branches and flying birds that might—I only say might—have come from beyond the Archipelago. But to go in search of other islands, other archipelagos, with no safe means of return," he shrugged, "it's more than any competent navigator would risk."

"But suppose there was no risk?" Now they were getting to the point of the meeting. In spite of himself, Rantor

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felt a stirring of hope in his breast. It was every navigator's dream, and although the chance of it being achieved was tiny, the fruits of the success would be so sweet that any possibility had to be explored.

He was yet young, and he had achieved a great deal. As much as anyone in his profession could achieve. Navigator to the Duke Kyper. What more could he ask? And yet, a restlessness burned within him still, a longing for something—he knew not what. But something to be sure, that could not be found in the Archipelago; for he had sailed the length and breadth of these islands and had yet to find the thing that would give him peace.

"You have a way of navigating beyond the Archipelago?" He made it a question, as desperate not to allow himself to be taken in by any false hopes as he was eager to find those hopes fulfilled. But the little man they called the Hawk had clearly been able to spot, immediately, the true response of the Navigator to even the hint of such an achievement.

It was his turn to smile. "A navigator, indeed. We both want the same thing, if for different reasons. And we can both serve our noble lord well, while following our own dreams. Yes, Navigator Rantor, I have a means to sail beyond the Archipelago, and find our way back again. How far we can sail, and what we might find, only God can say." The smile suggested that Hawk trusted more in the ability of himself and a human navigator than in the whim of God. "But I am sure the journey will be worthwhile, and with our lord's permission, I will explain."

The duke nodded. "With the understanding, Navigator, that none of this passes your lips outside these walls."

And so the Hawk had outlined his strange ideas for the first time. Since then, in many conversations, he had elaborated his dreams and his plans, until Rantor came almost to believe in them himself, just as he had grown to like the little man and to admire him for his strange genius. Whatever came out of this mission, he was sure, the Three Islands would never be the same again.

But still, the ideas were so strange; and having no one to discuss them with, except the Hawk, who had utter faith in his own beliefs, Rantor sometimes wondered if there might be flaws he lacked the wit to perceive, or whether he really understood at all. He'd give a lot to discuss the strange philosophy with a sympathetic priest—but pick the wrong priest to open his mouth to, and the price might be his life. Instead, lacking anyone to confide in but himself, he rehearsed the Hawk's strange image of the world in his mind, as he headed briskly for the workshop where, if all went well, he would see proof of this man's genius at work.

As a navigator, Rantor knew his geometry and trigonometry. From his own experience, not just the word of the priests or of the books they kept so closely to themselves, he knew that the sun did indeed shine down vertically on every island in the Archipelago. Of course, he had never felt any inclinations to make measurements, but all his own experience told him that when the priests—or Hawk—said that those measurements always showed the sun

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to be precisely at the zenith, they were speaking truly. An ordinary man might have trouble grasping the implication, but Rantor understood the nature of parallel lines. Parallel lines meet only at infinity. If the sun were any reasonable distance above the flat plane of the world, then careful measurements and triangulation, the same techniques used in navigation, would reveal its height above the islands. For it to always appear vertically above any spot in the Archipelago, it must lie at an infinite height above the flat world. So much was clear. But what else could be inferred from the observation?

He smiled to himself as he recalled the one occasion that he had —almost—discomfited Hawk with his navigational skills. Few people could think in terms of three dimensions, living as they did, on a flat plane. But the navigator had always enjoyed abstract mathematics. As he had pointed out to Hawk, some philosophers had noted that the sun *could* appear vertically above every point on the world if the world formed the inner surface of a hollow sphere, with the sun at its center. For a moment, even Hawk had been at a loss for words, struck by a novel concept. At least the mathematicians of the Three Islands had some tricks they could teach him! But then, his mind bright as ever, he had spotted the flaws in the argument with impressive speed. If the world was round, the Archipelago was lying at the bottom of the equivalent of a huge shallow valley. All the waters of the world would pour downwards, flooding the islands completely. The Sun itself would fall from the sky, following the natural tendency of things to seek the lowest point. It was merely a pretty piece of geometry, no more practical in its applications than Artemis's theorem of prime numbers, no more meaningful than the negative square root of a quadratic equation; a clever parlor trick. Indeed, the Sun *must* be at infinite distance, if this were the only alternative! A beautiful example of the doctrine of the absurd alternative—if two alternatives purported to resolve the same problem, but one "solution" was clearly absurd, therefore the second, however unlikely it might seem in everyday terms, must be the correct solution.

The priests taught, of course, that the world itself must also be infinite in extent, a flat plane extending eternally in all directions, a featureless ocean surrounding the Archipelago. Logic then dictated that there must be only one Archipelago, created by God as a home for man. In an infinite ocean, there could in principle exist an infinite number of Archipelagos, with infinite varieties of life upon them. This was clearly absurd. So the logicians argued that there must either be many worlds, or that the Archipelago was unique —since the fact of their existence proved the Archipelago to be real, even to philosophers. If there were infinite numbers of archipelagos, many worlds, man would occupy no special place in creation, and could not represent God's work. So, the priests reasoned there was only one Archipelago. Only heretics argued otherwise.

But Hawk claimed that the lights seen in the night sky from time to time were other worlds, like the world of the Archipelago. If so, they could not be in-

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finite in extent, for if they were, either they would fill the sky and block out the light of the sun, or their infinite planes would intersect the plane of the world. If they were finite worlds, islands in the sky, then the world of the Archipelago might also be finite. And in a finite ocean there might exist a finite number of Archipelagos, without running into the problems with infinities that plagued philosophers and tipped reasonable speculation into heresy.

Rantor shook his head, muttering wordlessly to himself as he strode along. To the Hawk, it seemed clear that an intersection of infinite worlds would be obvious to the inhabitants of the Archipelago; but the navigator was not sure. In an infinite world, an infinite number of other worlds could intersect its plane, and still the nearest intersection might be infinitely far away from the Archipelago. And if the lights were other worlds, what stopped them from falling onto the world? The Sun might well be falling. At infinite distance, it could fall forever and still get no closer to the Archipelago. But other worlds—finite worlds—floating like saucers in the sky?

The thought made his head spin. He pushed it to one side. Besides it was of no practical importance. Nobody suggested they might voyage to the worlds of those lights in the sky! Hawk's plan was crazy, but not that crazy. If the priests were wrong about the infinite extent of the world, Hawk argued, then they might be wrong in teaching that there was only one Archipelago. The fact that the Archipelago existed proved that there were islands, and life, in the world. And if one Archipelago could exist why not others? The other worlds Hawk sought were only (only!) other archipelagos existing on the flat ocean of the world.

Rantor had doubts about the argument, though he was willing to take a reasonable risk on the off chance of finding new islands to trade with. He was also more than willing to follow up any prospect of a technique to navigate out of sight of land, out of feel of the sea breeze, and land breeze, and to find his way back, not just to the Archipelago but to any island of his choice, infallibly. It would make his master, the duke, rich beyond compare, and some of the riches would rub off on him. And it would render established patterns of naval warfare obsolete overnight. If it worked.

Darkness came with its usual suddenness, although a few smoky torches had been lit in anticipation. The night glow, though something less than full darkness, such as you would experience in a closed room, was hardly sufficient light for any human being to see more than the vague shadows of buildings. Just ahead, the workshop that had been given over to the Hawk and his works stood out from its surroundings, lit up by the experimental gas lanterns that enabled the Hawk to work such long hours, and were the reason why he had been allocated that particular building for his efforts. Rantor frowned slightly at the sight. To someone who depended on the safety of a wooden-walled ship for his trade—and his life—fire was a mixed blessing. Wooden houses and warehouses were scarcely any less at risk. To be sure, the duke's artisans had been ingenious in devising this practical

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use of manure from the farms and from the earth closets of the town. But if they were to light more than a few buildings with the natural gas there would be no fertilizer left for the fields. No, gas lighting would remain a trick used only for special needs. And special needs, on the Archipelago, generally involved ships. Somewhere, somehow, some no good would come of this gas, Rantor was sure. But in the meantime, it meant he could attend Hawk's discreet demonstration at a time when most law abiding citizens were at home, or at least safely shut away in some comforting tavern. When the sun went out, it was far too dark to be wandering the streets.

Just before he entered the building, the navigator paused, shading his eyes and looking upward into the blackness, seeking a glimpse of the lights which Hawk set such store by. Of course, it was useless, His eyes were not dark-adapted, and even under ideal conditions, from the deck of a ship at sea, the lights never showed as more than a dim phosphorescence against the all embracing blackness of the sky.

Hawk was waiting for him, impatiently tinkering with the complex apparatus that spilled over two tables and out onto the floor at one end of the long gallery. His two assistants stood, nervously to one side. Armed guards, Rantor knew, filled the building. But all that mattered was Hawk himself and his strange experiment.

The tinkering stopped. "You are alone, Navigator?"

"Who else did you expect?"

"I thought . . . but . . . "

Rantor smiled. "I have the authority, Hawk, never fear. Persuade me that your trick works, and our lord will not gainsay my decision. He would not risk a valuable ship on such an errand without his best navigator, but if the navigator approves, then the ship sails."

"I suppose that's good." The Hawk's sharp mind had instantly appraised the situation. "Our Lord Kyper is an intelligent man, but he is an administrator, a soldier. It should be easier to make you understand, and then . . . " His voice tailed off. So much of his life had been leading up to this moment that the Hawk, for all his wit, clearly had little or no idea what would happen next. He would be in the hands of the navigator, embarking on a voyage into the unknown.

"Well, this is it." He gestured at the complex web of apparatus. "Don't worry about the details. Just watch." He nodded at the assistants, one of whom promptly moved to a bank of large glass jars, and stood poised to turn what looked like a small capstan.

Hawk continued to talk. "At this end of the room, we make artificial lightning. It's been done before but not on this scale. But down there," he pointed along the gallery," is something completely new, the sensor. When we make lightning here," pointing back to the main bank of apparatus, "the sensor responds. Come with me and see."

Following Hawk's lead, Rantor walked along the gallery. The sensor seemed a lot simpler than the lightning machine, which was just as well, since this was the equipment he was supposed to take to sea. The most prominent feature was a pair of metal spheres, about a thumb in diameter, almost touching one an-

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other. The whole apparatus, lightning machine and sensor, seemed, Rantor realized, incredibly profligate with metal. The value of the equipment would be more than the value of his own ship. The extent of the duke's commitment, and the implications of failure after such an investment, seemed to cause a pricking of the hair at the back of his neck.

"Perhaps you can feel the lightning in the air." So it wasn't fear! The Navigator smiled at his own foolishness,

"We can begin. Watch the gap between the two spheres." Hawk raised his right hand, and let it fall in a dramatic, clearly prearranged, signal to his assistants. At the far end of the gallery, one of them began to turn the small capstan. Immediately there was a crack, like thunder. In spite of Hawk's injunction, Rantor looked towards the sound at the far end of the room. A flash, like lightning, accompanied another thunderous crack, clearly somehow controlled by the turning of the wheel. Remembering his instructions, Rantor turned back to the apparatus before him. As the thunder continued, each crack was accompanied by tiny sparks leaping accross the gap between the two spheres. The lightning at the far end of the gallery was being reproduced, in miniature, at the sensor!

Hawk raised his hand again, the noise and the flashes, stopped. He shrugged. "We can only keep it up for a short time, with this equipment. But the full scale apparatus will be more effective."

"This is just a model?"

"Of course, I'm planning to build the real thing in the castle, high up. With your approval, and Duke Kyper's permission, of course."

"But how does it work?"

"The details are not important. It has to do with what I call the law of similarities. You will see that the construction of the sensor follows the pattern of the lightning generator. The morphology is crucial. When the lightning surges in the generator, there is a resonance in the sensor. The construction must be perfect, but when it is, we have the effect you see. I call it morphic resonance."

Rantor was intrigued. He studied the strange shapes of the small machine before him, then walked along the gallery to compare the image in his mind with the structure of the lightning generator itself.

"And that is all?"

"Not quite all. The sensor could not respond at a distance, even if it were a perfect resonator, without being primed. When set to receive, the resonant sensor is in a state where it is almost ready to make its own sparks of lightning, spontaneously. It has the potentiality to make sparks. The resonance does no more than tip the balance."

Rantor paid little attention to the words. As his initial surprise receded, he began to concentrate on the practicalities that concerned him.

"An impressive trick, Hawk. Everything you promised. Our lord will be pleased. But how do you intend to use the trick in navigation?"

The little man smiled. "It's wonderfully simple, Navigator. In my studies in my home island, before—well before . . . " Just how and why Hawk had left his home Rantor had yet to discover, though it was natural that anyone with a scheme to make money would grav-

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itate to the Three Islands and the court of Duke Kyper, " . . . I worked on an even smaller scale than you see here, but I discovered a curious thing, a way to shield the resonator from the lightning. A metal screen—it need not be solid metal, just a mesh—placed between the generator and the sensor prevents the resonance. Now, it seems to me that a navigator on a ship at sea, equipped with a resonator and a screen, need only move the screen around to find out which side of the sensor it blocks the lightning. And that must be the direction the resonance is coming from—the way home!"

He stopped triumphantly. Rantor thought; less impressed than, it seemed, the Hawk expected. It might work. Of course, it would be different, on the heaving deck of a ship, out of sight of land. But, yes, it might work. You could even rig a little circular track, for a truck like the ones used by the shipwrights in the yards, with the screen mounted on it. With stout hands at the ropes, and a good pulley system, you could run the shield around from place to place—well, no doubt any competent captain could attend to such details.

"Metal stops the ah, resonance, you say?"

Hawk nodded.

"But not stone?"

"No, no effect at all."

"So we can keep the generator securely shut away from prying eyes. Is there any limit to the resonance?"

Hawk shrugged. "That is for us to find out. Before I came here, with a smaller model, the sensor worked at a distance of seven hundred paces, through several intervening houses. At sea—over greater distances—who knows?"

"But even if it works as you hope, how long can the generator operate? How can the navigator at sea be sure to be seeking the signal at the right time?"

"A simple matter. We choose a time that cannot be mistaken—dawn perhaps. Every day at dawn, the generator runs for as long as possible. Every day at dawn the navigator has his bearing. All he has to do is hold a true course through the day."

The navigator smiled. An easy enough task, he said quickly. It almost made you wonder why the dukes and lords bothered to cosset their navigators so. In fact, it would tax his skills to the utmost to make effective use of this trick. Which, to be sure, was one reason why he found the prospect so appealing.

Rantor was used to making decisions, and acting on them. He clapped Hawk on the shoulder.

"We will find out, Hawk, just how simple a task it proves. The duke has put a new ship, the *Far Trader*, at my disposal. A two decker sixty paces long. You can get your sensor aboard tomorrow, I trust? And then we'll see what it can do."

"Tomorrow! Why, we can start now—my assistants know what to do—"

"And can they see in the dark like cats?" Rantor laughed. Tomorrow will do, my friend, but meanwhile, I know an inn, indeed, more than one inn, not far from here. If you would care to join me?"

Stepping out into the darkness of the street, blinded by the change from the gas jet inside, Rantor stumbled and grasped at the wall for support.

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"Damned torches. Always let you down when you need them, Hawk. Your next job ought to be to find a way to make that lightning generator of yours provide a steady glow. Then we could —" He turned at a sound behind them, hand moving to his sword. "Hold! Behind me, Hawk."

Idiot! Of course those torches hadn't burnt out yet, in this quarter of the dock patrolled by the Duke's men. Somebody was out there—somebody with eyes well adapted to the dark.

He drew the sword, edging backwards as he became aware of three—no four—shadowy figures confronting him.

"In the duke's name! I am the navigator, Rantor. Anyone who harms me, or my companion, will answer to Lord Kyper."

Surely nobody could be so foolish? Rantor himself represented the duke's most valued possession. No rival lord would harm or kidnap the navigator; several might like to, but that would give the Duke his excuse to crush the opponent foolhardy enough to take such action, picking off his adversaries one by one, before they could organize against him. All the lesser lords would support the duke in any action he took in defence of the navigator. Without navigation the Archipelago would cease to be civilized.

The figures moved, two straight for him, one to either side. Professionals. No chance, four against one, but they'd know they'd been in a fight. The sword flicked out, met another blade, parried. And swung to the side, striking at the second swordsman. Rantor felt the jar as it stabbed through flesh and jolted along bone. But before he could withdraw to strike again, two of the hooded figures held him in their grasp. The fourth had the terrified Hawk, who had taken no part in the action, at sword point.

Only now did one of his two captors speak, as the other bound Rantor's hands.

"My apologies, Navigator. We intend you no harm, but it seems expedient to borrow you for a while. It is your companion whose services we seek, and whose activities are of interest to our lord."

The second man turned his attention to his wounded companion who was leaning against the wall, holding his cloak against his side. They spoke briefly, then the wounded man moved off slowly into the night, staying close by the wall. Their remaining captors pushed Rantor and Hawk back towards the workshop entrance, swords prominently displayed. In the doorway, a flash of reflected light showed where the guards, belatedly aroused by the scuffle, waited.

The same man, clearly the leader of the band, spoke up again.

"Guard! We have your navigator, the esteemed Rantor, as you see. Duke Kyper would surely wish no harm to befall such a valuable servant! Give us access for a few minutes, and he will be released unharmed."

The navigator fumed inwardly. It would work, he knew. No soldier would risk the duke's wrath by allowing Rantor to be harmed. Whatever their orders concerning the Hawk and his toys, the guards would only move against the kidnappers if there was no risk to Ran-

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tor. Not for the first time, he cursed his privileged position.

Inside, disarmed, bound, and with cold steel held to his throat, he could only watch, helplessly, as the first raider examined the impressive collection of apparatus, Hawk's lightning generator, at the near end of the gallery.

Outside, a creak of harness and a snuffle of horses indicated the arrival of more raiders, with transport. They intended, Rantor realized, to take the generator with them. Nothing could be done, unless the guards were willing to risk his life. For a moment he thought of flinging himself on a sword. If he were dead, the guards would have to act. But it was true—he was worth more than Hawk and his apparatus, quite apart from his reluctance to end his own life. But perhaps there was a way.

He flung up his arms, bound as they were, crying "Hawk!" At that movement, the knife of his captor pressed more closely against his throat, drawing a red line of blood. "Do as they command." Emphasizing his words he dropped his arms back downward, clumsily, but consciously echoing Hawks earlier signal to his men. The pressure at his throat eased.

"Or you will never see another dawn. Do you understand? Take your machine, and use it as they command. This navigator is indeed worth more to our lord than you and all your toys. Is everything still in place?"

The bright, darting look of an intelligent bird was back in Hawk's eyes. As Rantor had hoped, he turned and walked back towards the generator, and made a show of inspecting it closely.

"Yes, Navigator, everything is here. All in working order."

"Then let us go." The chief raider spoke abruptly. Two other cloaked and hooded men had entered the room. He gestured at the generator, and at Hawk. "Take everything, and him. The brave navigator," he raised his voice to the guards lined against the wall opposite, "stays with us for a while. If no one follows, he will be released. Otherwise, your duke can seek another to guide his ships."

"Oh yes lord, I'm certain enough." The navigator, unable to contain himself, strode impatiently to and fro across the large room, slapping his thigh with the gloves he carried in his right hand. He was dangerously close to insubordination, but the duke had to permit him to act. He had played the coward intentionally, planning to rescue Hawk and his lightning machine and to strike a blow for the ruler of the Three Islands. If Duke Kyper's caution prevented him from moving, the story of his desertion of a servant in his charge would ring round the fleets of the world.

He stopped pacing, and faced the Duke squarely across the table, hands resting flat on the surface. "They were Ballestre's men. I know their ship, and I can find the Hawk. He will voice a public protest and you will be free to slap Ballestre down. No one will interfere. Not Falco, nor Langan. You will have proven just cause."

"And if you fail to find Hawk, but Ballestre finds you adventuring in his domain, then he will have just cause against me. Falco and Langan will side

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with him; others too, perhaps, while the lesser islands hold back."

"But if you take no action, sire? This time, you have lost little. The machine is probably worthless; Hawk is a fool—you said so. But if word gets out that a raider from a Ballestre ship can take his pick of the property of Lord Kyper, in the middle of his own shipyard?"

The duke looked steadily at his navigator.

"You are so sure then, that Hawk and his toys are worthless?"

Against that steely gaze, Rantor wilted. "Lord, I . . . "

"And you would take such risks, solely for the honor of the Three Islands, and yourself?"

There was nothing more to say. Rantor felt a glow of triumph. The duke might banter, but he was going to agree!

"How many men do you need?"

"Forty, fifty at most. The new ship, the *Far Trader;* and those two assistants Hawk was training."

"And your plan?"

He shook his head. "Forgive me, Lord. I fear that there are spies in our midst. How else could those raiders have known where and when to strike? But have faith, and in a fiveday, perhaps two, I shall return Hawk to you and give you just cause to strike at Ballastre. After that, no island will dare to cross you.

Far Trader slid slowly towards the beach, sails furled, under muffled oars only. At this time, just before dawn, the breeze was off the land. It would stay that way for some time after the sun began to stir, ideal for their escape. After six days, cruising slowly along these shores in the dark, and further out to sea in the early part of the day, the Navigator had a clear idea of the position of the Hawk. The hours spent closeted below decks seemed to have paid off, but his men knew only that he had the information required. The rumor below decks was that he had a spy in the enemy camp. He had encouraged the rumor, and his obvious confidence had encouraged the faith in both the rumor and himself.

Ballestre had, if Rantor was correct, chosen a good place for his captive to work. The isolated watch tower was far enough from the town that any untoward events would cause no damage—Rantor remembered some of the mishaps in the early days of the gas lighting experiments and approved of such caution. The tower was also far from the harbor, up a steep path. No attack from that direction could possibly take its garrison by surprise. It was, however, vulnerable from another direction. A small landing party, in the bay around the headland, could approach the tower from the rear—if, that is, any such raiding party had reason to suspect the activities now going on there. Ballestre had taken pains to ensure that no hint of those activities had leaked out. But he was in for a surprise.

"This will do." Rantor spoke quietly, but without whispering. The captain nodded, and gave the necessary order in an equally matter-of-fact voice. The chain of command was clear, and established by long practice. The navigator decided what to do, where to go, and when. The captain decided how to do it, and ran the ship. If a navigator

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asked the impossible, or demanded a course that would lead his ship into danger, a captain might refuse and argue his case later with the duke. But this was almost unheard of. Navigators didn't get to be navigators by taking unnecessary risks.

A single anchor at the stern held the ship with the bows pointing seaward in the light breeze. With the oars shipped, two boats were lowered into the water.

"Pull." A single word sent the laden boats scudding into land. With two men left to guard them, Rantor had just fifteen at his back as he led the way up the slope to the tower. They stopped in the cover of a small copse, perhaps a hundred paces from the target. The ground between was scrubby. Sloppy work, thought Rantor, as he checked out a possible way forward. At a gesture, two bowmen and two others, with ropes coiled over their shoulders, stepped forward. Wordlessly, Rantor pointed a way forward, from cover to cover. Then he pointed up to the top of the tower, ten span above their heads. The four nodded and moved swiftly forward, lost in the darkness and the bushes

The sound of the two grappling hooks biting into the top of the tower was swiftly followed by the twang of two bows and a stifled cry—as, if all had gone to plan, the sentries drawn by the noise of the grapples had been picked off from the roof.

Waving his men on, Rantor ran forward and began to swarm up one of the ropes

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The action was over in minutes. It was still dark as the party returned to the boats, carrying one dead, two wounded, and the large glass jars which Hawk insisted they could not leave without. The burdens slowed them down more than Rantor expected; in addition, someone had been left at the tower with his wits about him, and sufficiently unscathed to mount the stairs of the tower. The boats were still pulling hard for the *Far Trader* when an orange glow appeared on the headland. First a mere flicker of flame, but soon burgeoning into a leaping pillar of light. Cursing, the navigator exhorted the already straining men at the oars to pull harder. Even as they came alongside the ship, however, he knew that Ballestre's vessels, in the harbor round the headland, would already be bustling with life and preparing for action. It would be nip and tuck. Just let *Far Trader* get to seaward of Ballastre's ships, and he was sure the captain would show them a clear pair of heels. But if they were cut off . . .

"Abandon the boats." Captain Bryon was clearly aware of the need for haste. "Cut the cable. Get those men onto the deck. And all sail." This with a glance back towards the dark land behind him, not so much to see the land as to feel the dying breeze on his cheek, gauging how much life there was left in it. Just let them get to seaward of the fleet, and with the sun bringing the sea breeze onto the land nobody would ever catch the *Far Trader*. Scarcely twenty leagues away, through the doldrums, the welcoming breeze onto the land would usher them swiftly home to the Three Islands.

"Careful there!" Hawk's cry came as a stumbling seaman threatened to drop one of his jars. "Put it here, on the deck. Navigator," he turned, "it

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was brilliantly done. I take it the sensor worked?" They clasped hands, sharing their delight in the brief lull while the captain prepared the ship for action.

"Beautifully. Oh," a dismissive wave, "I don't say we didn't have some troubles. But your assistants are well trained. Every dawn, as we patrolled, they found your signal. The direction finding is poor, but with three successive bearings, why even the most unlikely 'prentice navigator could have pinned you down to the headland—and there is only one place on the headland where you could have been. My only concern was that you would misunderstand my intentions, or be unable to persuade your temporary master to allow you to experiment."

Hawk laughed. "No fear of that. They'd have had me at work night and day, once I let on that I was developing a technique to turn rock into metal. Duke Ballestre is a greedy man. But I persuaded him that my method depended on striking a resonance with the newborn Sun—and also, of course, that it required some separation from the center of the town. I had those soldiers of his fair jumping every time I shouted 'frog'; but tell me," his voice changed as he looked about, "we are still in danger, are we not?"

Rantor, also suddenly grave, looked about the darkened ship, where only a few faint lights relieved the gloom. The headland must be there—his sense of direction seldom failed him, even in the pitch of night—sure enough, just beyond he caught a quick flash of light, then a second. He nodded at his companion.

"Grave danger, friend. On the open sea, no ship could find us, or board, at night. But here, with only one clear channel, they can feel their way out," he nodded forward to where a stocky sailor was coiling a long line, attached to a stone, ready to throw it over the side to gauge the depth of the water, "and cut us off. A little longer, half a candle or less, and we might have been clear. As it is . . ." he shrugged.

"Perhaps I can help. Your captain—is he a good man? Will he follow my advice?"

"Bryon? We've often sailed together. If I give the word, he would sail into the maelstrom itself. But if you have a plan, be quick about it, for time is short indeed."

Three ships, their riding lights clear, blocked the channel ahead of the *Far Trader*. Ahead, tantalizingly close, lay the open sea, and freedom.

Backing her oars, *Far Trader* slowed almost to a halt, but continued to drift slowly down on the ships. At the word of command, she could surge forward —to certain destruction, or if the other ships allowed her, to an instant escape. The catapults were wound and armed, but they were inaccurate weapons at best in broad daylight. Naval engagements were settled by boarding and hand-to-hand fighting. Besides, it was one against three.

"Yield! Yield or suffer the consequences!" Astonishingly, the cry came from Captain Bryon, at the bow of the ship.

There was a brief silence. Were they stunned by his audacity? Or simply sorting out seniority among the gaggle of seamen, soldiers and civil administra-

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tors aboard the craft? Bryon pressed home his slender, momentary advantage.

"We have the Hawk. And his weapon. Yield, or we will use it."

At last, the reply came. But it lacked the confident tone of Bryon.

"There is no weapon. We have the advantage and you must yield to us. We have no reason to fear you."

The Hawk, busy at the bows of the *Far Trader* with his two assistants and a mess of equipment, centered around those glass jars he treasured so much, nodded to the captain. With the slow forward way still on her, *Far Trader* was scarcely a stone's throw from the ships blocking the path. The navigator, in the waist of the ship, murmured a quick "Ready" to the oarsmen. At the bow, Bryon raised his voice again.

"We will give you one chance. Our Hawk commands the lightning. One time, and one time only, he will demonstrate his power. Then you must yield, and follow us to the Three Islands. Or be struck down where you lie."

He raised his right hand. "Be warned, you doubters!" He let it fall. There was a brilliant flash from the bows, a shaft of lightning fully a span in length, arcing and wriggling accross the bows, almost touching the nearest Ballastre vessel. A strange pungent smell, a smell of lightning, drifted back. Cries of alarm came from the ships ahead, as their oarsmen, unbidden, began to back water. A gap appeared.

"Now!" cried the navigator, and the disciplined oarsmen of the *Far Trader* laid to their task. The ship shot for the gap, and was through in two strokes. Three, and there was clear water behind her; four, five and she was away, in the dying sea breeze, heading for open ocean. With the oarsmen given strength by the thrill of their success, and their opponents thrown into disarray, however temporarily, their safety was assured.

Forgetting his dignity, the navigator ran forward to where the Hawk glumly surveyed the wreckage of the equipment. Oblivious to the congratulations being showered upon him, he looked up only at Rantor's hail.

"Well done. Oh, well done indeed. This story will be told in all the ports on the Archipelago! The night the Hawk brought down the lightning!"

"Aye, but at what cost?" Hawk indicated the wreckage of the equipment, metal melted into fantastic shapes. The small sphere from the sensor, unrecognizably distorted; glass jars broken.

At Hawk's feet, a half-sphere of metal, about the size of a cupped fist, rocked slightly with the motion of the ship. It was part of one of the larger spheres, come apart around its seam. He picked it up, holding it in the palm of one hand. At the bottom of the hemisphere, a small puddle of water had collected from the spray; following the natural tendency of things to seek the lowest point, it sloshed to and fro as Hawk swayed with the roll of the ship. He inverted the hemisphere, and the water fell out on to the deck. Miserably, he offered the useless object to Rantor.

"This is ruined, and the rest has been left behind. Years of work."

"But you have your life, Hawk, and your liberty. Never fear for these trifles. Ballestre is disgraced, by your testi-

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mony, and our Lord Kyper will be generous in gratitude. This ship will be fitted out with all that you require, and together we will sail beyond the Archipelago, sure of finding our way home. What sights we shall see, Hawk, if your philosophizing is correct, and what riches we shall bring back!"

His enthusiastic excitement roused Hawk from his gloom. "You really think so? It isn't an unmitigated disaster after all?"

"Oh no, my friend. At last I know what my life has been leading up to and where I am going. You have given me a new sense of direction and I thank you for it."

As if to emphasize his words, the sun high over their heads lit up in its usual manner. It was dawn; the dawn of a new era for the navigators of the Archipelago.

Patterns of impulses raced at the speed of light through an alien mind, collating, observing, interpreting. Especially observing; that had been the task of the mind since time immemorial. Responding to ancient imperative, the observer watched, and waited, patient as only inorganic intelligence could be, for the signs it had been programmed to detect.

The disturbances caused by the lightning generator had briefly held its attention. Weak, erratic and probably natural disturbances in the electromagnetic spectrum, coming from the region of a small group of islands in the southern hemisphere. They contained no information though, and they stopped after a few cycles of light and dark. They were not the signs of intelligence that the observer was programmed to recognize. It felt no disappointment. This was far from being the first time that some temporary change in environmental conditions had suggested, erroneously, that the long wait was over, and besides the observer was not programmed for emotions. The incident was noted for comparison and cross-correlation with future disturbances. The observer went about its business quietly, calmly, as it had done for millennia past.

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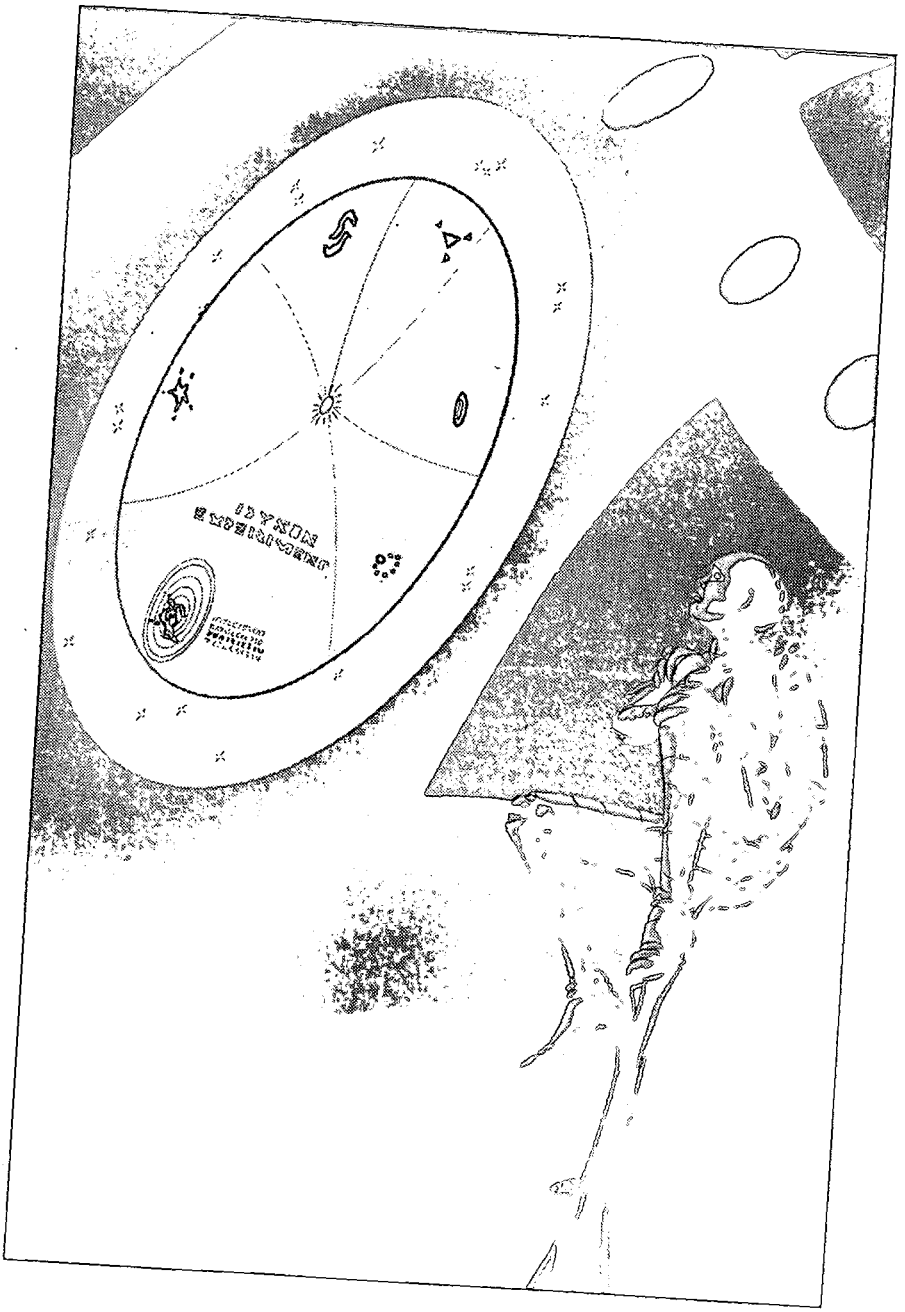

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The Alternate View

COMPUTER ILLITERACY

G. Harry Stine

It was pointed out by a computer wag that a computerized system consists of three subsystems: hardware, software, and jellyware.

Hardware is the computer itself—the collection of slightly impure chunks of silicon dioxide and other metal oxides that sometimes conduct electricity and sometimes don't, but never conduct it very well. Basically, hardware is mostly sand with some metal and some organic plastic material to hold it together.

Software consists of the instructions necessary in order for the hardware to do things. The instructions are nothing more than signals indicating that certain pieces of hardware are to turn themselves on or off in specific sequences at specific times in specific areas of the hardware. The basic instructions are written or given in binary terms—on or off—and other software elements translate this to and from the more complex language used by the next element in the system.

Jellyware is the human being who tells the hardware what to do, who gives the hardware its data, who utilizes the output of the hardware, who writes the software, and who *uses* the output of the hardware. Jellyware itself is a computer consisting of hardware and software. Jellyware is mostly water with specific and small amounts of impurities in certain locations. The jellyware's software is mostly preprogrammed (ROM in hardware/software terms) with some RAM that is inputted as a result of experience.

Hardware and jellyware differ only in the fact that hardware is made up of crystalline structures while jellyware consists of colloidal structures. The jellyware's operating systems appear to function in the parallel mode while those of the hardware operate in a series mode. However, the output of jellyware is one-channel sequential and series in form. Like hardware, jellyware can do only one thing at a time.

So much for the background. Now you know far more about computers than the majority of the population of the United States.

This is because the majority of the people in the United States are computer illiterate. It's not only true that hardware cannot understand jellyware without software—hardware is illiterate—but jellyware can't understand hardware at all because jellyware must deliberately program itself. And most jellyware can't do this or won't do it.

As an author, I am naturally concerned that a surprisingly large percentage of the population of the United States is functionally illiterate; if they can't read or cannot understand what they read, they won't buy books. Or this magazine. But as a citizen and a technological visionary, I'm really bothered over the fact that people are computer illiterate. They are either afraid of computers or cannot operate them.

Too bad, because our culture and our economy are becoming computerized with alarming speed as rapidly as economic factors will permit. (Hardware

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and software are expensive and require a large up-front capital expense in the hope of reducing operating expenses down the line. Many operations will continue to use jellyware rather than convert to hardware/software because jellyware is far more versatile. Furthermore, unlike hardware, jellyware can be produced by relatively unskilled labor. . . .)

Far too many people will never be able to operate a computer via a keyboard because (a) they do not know the English language which the computer has been programmed to recognize and (b) they cannot operate the keypad. Think not? A surprising number of people cannot operate a simple adding machine (although the ubiquitous touch-tone telephone has forced them to learn how to punch a 12-key system if they want to talk to someone else, and more about this in a moment). Fewer yet can operate a manual or an electric typewriter. Therefore, a lot of people cannot operate the QWERTY keypad of a modern computer.

In short, the jellyware doesn't know how to talk to the hardware.

When the hardware talks to the jellyware, it is necessary for the jellyware to be able to read what the hardware and software have so laboriously translated out of machine language into the written word. Many people can't read. It's also necessary for the jellyware to be able to understand what they read. Another alarming statistic.

On a recent airline trip, the young lady sitting next to me spent the whole three-hour flight studying a text and workbook on retail business practices. The book was telling her how to fill out a sales slip. She was laboriously doing this in the workbook. She would have been better prepared for a retail business job if she'd been learning how to add a column of four-digit numbers rapidly in her head. (The computers don't always give the right answer primarily because humans make mistakes with the data input. Thus, it helps to be able to have a grasp of a "ball park number." If the calculator comes up with a total that's not in the ball park, you know you should go back and re-renter the numbers to be added.)

All of this bodes ill for our culture in the future.

Although Arthur Clarke has written that we are proceeding pell-mell into a computerized service culture, I don't think Arthur has realized that we're faced with an enormous problem at the human/machine interface.

That's the crux of the problem. And the computer designers and engineers had better get on the stick and do something about it, or the market for computers is slowly going to become saturated because of the large number of people who are computer illiterate.

What to do?

If the interface is the problem, the thing to do is to transfer some of the creative energy of the hardware/software designers away from making the hardware bigger and faster and into the area of making the interface easier for people. Human beings are basically members of a visual and verbal species. We have to learn how to operate machines through the eye-brain-hand system, and some people never catch on. (Almost anyone can learn to operate the two-degree-of-freedom system called a railway

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locomotive; most everyone eventually learns to operate the four-degree-of-freedom automobile; only 750,000 people in the United States know how to operate the six-degree-of-freedom system called an airplane. As the degrees of freedom of systems increase, fewer people can learn to run them.)

But, boy, do we talk to one another! And sometimes we even listen.

We seem to be a verbal species. Long before we became literate, we were verbal story-tellers. The ability to communicate verbally beyond simple commands and warnings (the higher apes and some monkeys communicate on this level, as do the cetaceans) is a distinctly human attribute. In fact, it may have been one of the first factors used to discriminate between animal and human—i.e., if the baby could learn to talk, it was accepted into the early human clan, and if it couldn't it was eaten.

The ability to verbally communicate ideas and concepts is ingrained extremely deeply in our brains and minds. As many psychiatrists will confirm, the verbal centers of the brain are very powerful and very basic, which is why hallucinations are initially experienced as verbal (voices heard in the head) before they are experienced at a higher level as visual images. In spite of the fact that we watch a lot of television in our culture, voice-only radio is *still* an extremely powerful communications (and selling) medium; there are far more radio stations in today's television-dominated media world than there were 40 years ago, before TV became so commonplace. And in spite of the fact that the technology that would permit economically-viable video telephones has existed for at least 50 years, we find that voice-only telephone communications are far more widely used.

(FAX is now up-and-coming, but its utility seems to be primarily concentrated in the speed-of-light transmission of communications that *must* be in writing in order to preserve them or maintain a record, which is why the Sumerians came up with writing in the first place. One of the big failures of the otherwise highly successful Federal Express operation was ZapMail, whose marketing overlooked the development of facsimile technology.)

The first step in overcoming computer illiteracy would seem to be the further development of voice-actuated data systems.

I would *love* to have dictated this column into my computer instead of keying it in! In the first place, I *hear* it in my mind anyway because my thoughts are expressed and structured in English words and sentences. It would be far easier to vocalize what I'm thinking and have my word processor recognize what I'm saying and translate it into the written word.

Yes, I know all about the problems with words like "no" and "know." I wish to point out that the correct spelling of these and other homophones can be deduced by sufficiently advanced artificial intelligence systems because of the use of these words in context. Algorithms already exist to handle this as well as to determine the spelling of words. One of my computers is seven years old and runs CP/M (!) but it has a 50,000-word spelling dictionary. So this isn't new technology.

In fact, most of the technology needed

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to implement real voice data systems exists, but a lot of it has been passed over and left on the shelf because of emphasis in developing hardware speed and software utility. Now that technology can be used to develop jellyware literacy!

In short, we can achieve voice-actuated data systems today. Doing so means solving economic problems, not technical ones.

The same holds true for the direct human-computer interface, but that's another subject. ■

IN TIMES TO COME

● Our last issue of 1988—Mid-December—features a striking cover by Alan Gutierrez for a novelette introducing two new writers, Timothy Perper and Martha Cornog. "Guz's Place" is a neighborhood place, and one that you'd probably like in *your* neighborhood. Ethnic restaurants are not a new concept, which is precisely why this one's proprietor(s) chose it as a means to their ends. First contact doesn't have to be loud or flashy, you know—but then, certain human institutions tend to be a bit awkward in dealing with the unfamiliar. . . .

We'll also have W. T. Quick's "Social Contract," a sociological speculation not so much of the "if this goes on" school as "what if we change direction *so?*" Pauline Ashwell has another in her unfolding series of stories about a rather unusual science fiction convention, and we'll also have short stories by Joseph H. Delaney, Stephen L. Burns, Elizabeth Moon, and at least one new writer worth watching. Plus another fact article by Martyn J. Fogg, taking a closer look at just *how* folks like us might adapt to worlds with differing gravity.

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a calendar of analog upcoming events

25-27 November
DALLAS FANTASY FAIR (mostly-media and comics-oriented) at Marriott Park Central, Dallas, Texas. Registration—$15 for all three days in advance, $20 at the door. Info: Bulldog Productions, Box 820488, Dallas TX 75382. (214) 349-3367.

25-27 November
DARKOVER GRAND COUNCIL MEETING (MZB and related fandom conference) at Marriott Hunt Valley Inn, Hunt Valley, Md. Info: Darkover Grand Council Meeting 11, Box 8113, Silver Spring MD 20907.

25-27 November
LOSCON 15 (Los Angeles area SF conference) at Pasadena Hilton, Pasadena, Calif. Guest of Honor—Vonda N. McIntyre, Artist Guest of Honor—Patricia Davis, Fan Guest of Honor—Stan Woolston. Registration—$20 until 9 November, $25 at the door. Info: Loscon 15, % LASFS, 11513 Burbank Blvd., North Hollywood CA 91601.

2-4 December
TROPICON VII (South Florida SF conference) at Lauderdale Surf Hotel and Marina, Fort Lauderdale, Fla. Guests—Poul Anderson, Walt Willis, Karen Anderson, Madeleine Willis. Registration—$16 until 31 July, more thereafter Info: SFSFS Secretary, Box 70143, Fort Lauderdale FL 33307.

24-25 December
POLARCON '88 (High Arctic SF conference) at the Workshop. Guest of Honor—K. Kringle, Artist Guest of Honor—Jack Frost, Fan Guest of Honor—Blitzen. Registration—free but limited to good little girls and boys.

20-22 January 1989
ICON 13 (Iowa SF conference) at Roadway Inn, Coralville, Ia. Registration—$15 until 1 January, $18 at the door. Info: ICon 13, Box 525, Iowa City IA 52244-0525.

27-29 January 1989
BOSKONE XXVI (New England SF conference) at the Marriott & Sheraton Tara, Springfield, Mass. Guest of Honor—Tim Powers, Official Artist—James Gurney, Special Guest—Tom Whitmore. Registration—$25 until 15 December 1988, $40 at the door. Info: Boskone XXVI, Box G, MIT Branch Post Office, Cambridge MA 02139-0910.

31 August-4 September 1989
NOREASCON III (47th World Science Fiction Convention) at Sheraton-Boston Hotel & Hynes Convention Center, Boston, Mass. Guests of Honor—Andre Norton, Ian & Betty Ballantine; Fan Guest of Honor—The Stranger Club (Boston's first SF club). Registration—$60 (adult), $40 (child) to 15 September 1988; $70 (adult), $45 (child) to 15 March 1989; $80 (adult), $50 (child) to 15 July 1989. Supporting—$20 at all times. No advance memberships after 15 July 1989. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition, the works. Join now and get to nominate and vote for the Hugo awards and the John W. Campbell Award for Best New Writer. Info: Noreascon III, Box 46, MIT Branch, Cambridge MA 02139.

Items for the Calendar should be sent to the Editorial Offices six months in advance of the event.

—Anthony Lewis

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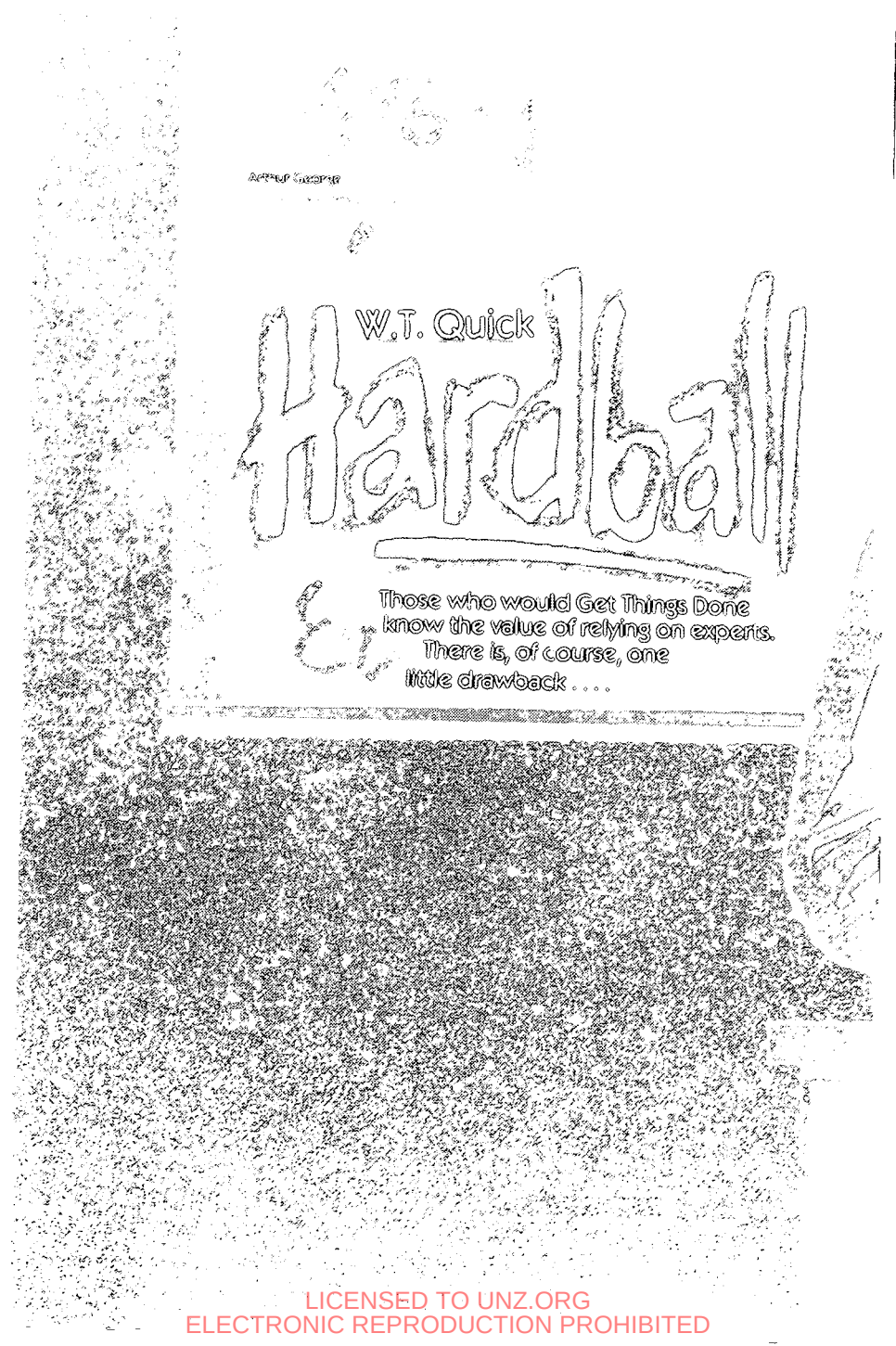
W.T. Quick

Hardball

Those who would Get Things Done know the value of relying on experts. There is, of course, one little drawback . . . .



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Doctor Arthur Rendell had no hobbies nor did he putter. He was bad at parties and his fund of social conversation was constantly overdrawn. He thought himself short, bald, and uninteresting, and he mildly suspected that others, perhaps even his wife, felt the same. He was therefore surprised to find that the United States government regarded him as one of the most fascinating men in the world.

"Twenty-five million dollars," he whispered to Dot that night. She was a comfortable gray woman who had once been quite a freestyle dancer. Now she pushed her bifocals up on her forehead and peered at him across the coffee table. "That seems like a great deal of money, Arthur."

He raised his eyebrows. "It's the kind of money they throw at young hotshots, computer whizzes and particle physics kids. Biogenetics wizards. Not old plodders in the English department, five years from retirement."

She lowered her glasses. "You're not old."

"But I plod, Dottie. I do plod. You said so yourself."

"Well, a little." She smiled. "But you're supposed to plod, dear. The doctor told you. Your heart and all."

"Forget my heart. Think about a twenty-five million dollar grant. Think about that!"

She tasted her tea, made a face, and put it down. "Needs more bourbon," she remarked. "Arthur, why do they want to give you a grant like that?"

He reached behind the sofa for the bottle of Jack Daniels, twisted out the cork, and added a tod to her teacup. She sipped again. "Better," she said.

"I don't know. That's the funny thing. I didn't understand their proposal at all. And I never did apply for that grant."

"Are you sure? It didn't just slip your mind?"

"I'm not senile," he said tartly. "I didn't apply for any grant at all." He paused. "Anyway, you get what deserts you pay for."

"What?"

"Nothing," he said. Carefully he added another wee dram to her tea. "Anyway, I'll find out more tomorrow. Dean Stanton has summoned me to a meeting." He picked up her teacup. "You know," he observed. "Bourbon *is* thicker than water."

Dean Stanton laughed heartily. He had a thick, leathery face topped with a very short white crew cut. He wore tweed jackets that resembled horse blankets, and when he shook hands he tried to squeeze fingers into paste.

Rendell despised him.

"This is great, Rendell, great! And for a scholar of your age, too."

Doctor Rendell pushed himself back against the edge of a monstrously ugly cherry sideboard and clutched his tumbler of scotch and water more tightly. Outside the high-ceilinged, oriental-carpeted office a few errant flakes of late winter snow dusted against the windows. But the sky was clearing rapidly and the fire crackling in the fireplace across from him was almost transparent in the morning brightness.

"What a plum for the English department!" Dean Stanton roared again. He'd already had one drink before Rendell arrived and was mixing a second

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when he admitted the doctor to his office. "Now listen, Art, when this General whatsisname gets here, you let me do the talking. I know how to handle birds like this."

Rendell nodded slowly and sipped his drink as lightly as he could. He hated scotch, but Dean Stanton hadn't asked. He'd just shoved the drink in Rendell's hand and bulldozed forward on his recitation of triumphs to come.

Rendell almost said, who is he giving the grant to anyway? You or me? But he didn't, which was a shame. It would have saved a lot of trouble later on.

"Dean Stanton," he asked instead. "Do you know this uh . . . General Huggins?"

"Seen him around," Stanton bluffed heartily. "At a couple of administration parties. He usually deals with the science boys, but I've been introduced."

"What's he like?"

"Big man, very patriotic. Those piercing blue eyes, and red hair going to gray like some kind of Viking warrior. Scares the crap right out of you when he puts those eyes on you and starts talking. He grinds his teeth, you know, but I don't think he's aware of it."

"I wonder what he wants with me?" Rendell muttered to his drink but Stanton answered him anyway.

"Doctor, who cares? He's money, that's all I know." Now the dean's voice went grim. "And Arthur, this department can use money and prestige like that. I'd hate to be the man who screwed that up. You understand?"

Rendell nodded and put his drink down on the cherry sideboard. "Of course I do," he said. But he didn't. Not then. Not really.

"He's here," Stanton said as a bell chimed softly from his desk. "Remember what I said about me doing the talking."

Rendell retreated to his post by the sideboard, partially shielding himself with its ornately carved bulk.

General Huggins strode into the office. Immediately he dominated the room. He was a tall man, straight-backed and broad shouldered. Rendell could imagine him posing for a recruiting poster in his youth. Surprisingly, however, his voice was soft, almost lisping. It was incongruous, and it sent a shiver of unease through Rendell. It was the voice of a psychotic.

The general glanced at Dean Stanton, but his eyes were for Doctor Rendell. He smiled widely, revealing huge white teeth, and immediately marched to the sideboard, his hand extended.

Rendell took the general's hand and regretted it at once. "Ow," he said, and looked sheepish.

"Oh. I'm sorry, Doctor. Just don't know my own strength, I guess," Huggins murmured. Rendell looked down at his mangled fingers and thought the general knew precisely his own strength.

"Quite all right, General," Rendell said, and tried to keep the waspishness from his voice. "I'm pleased to meet you."

"And I'm very pleased to meet you," the general replied. "You had a good conversation with my aide yesterday? Everything went well? I'm telling you, Doctor, you make me a proud man. I can't imagine anything better than hav-

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ing you on the team. On *America's* team, that is."

Now Dean Stanton rumbled over, his face set in a determined mask of academic joviality. Not for nothing had he braved a hundred faculty cocktail parties and even a presidential commission or two.

"Ah, General, welcome. Good to have you here. I can't tell you how excited I—we, I mean—are about your proposal."

The general turned and took Stanton's proferred hand. His blue eyes glittered brightly as he pumped, and kept on pumping until Stanton, tears starting, wrenched his hand away.

"Yes," the general said. "Naturally, it's all up to Doctor Rendell. He's the man we want on the team. No other reason," he added, seeming to enjoy Stanton's, sudden, crestfallen expression.

"Well, ah, of course, General. Art is one of our most respected people. Certainly he is. Very valuable."

"His *Principles of Semantics in the Modern Age* is the benchmark in the field," General Huggins said. "You've read it, of course?"

"Ah . . . of course," Stanton said. Doctor Rendell grinned. The only things Dean Stanton read were performance reports with which he terrorized younger faculty unlucky enough not to have tenure.

"General?" Rendell said.

"Yes, Doctor?"

"I have to tell you I don't really understand this. What possible reason could you have for wanting a semantician on your team, as you call it? I presume this all has something to do with the military. What do you need with a dusty old student of words and symbols and meaning?"

The general paused, as if marshaling his thoughts. He nodded slowly, once. "I can't really discuss the details at this moment, Doctor. Security, you know. All I can say is one word." He paused again, draping the silence with significance. Then, with trumpets blaring in the background, he said, *"Starblaze!"*

Rendell shook his head. Obviously he should have understood the word. Huggins was smiling as if he'd just explained everything.

"I still don't understand," Rendell said softly. "What is a Starblaze?"

Now it was Huggins's turn to look nonplussed. "Not 'a,' Doctor. 'The.' Starblaze is a system. America's space defense network. The bulwark of the Free World."

Rendell listened to more trumpets play around that capitalization.

"Space defense?" he said at last. "You mean weapons? Oh, well then. I'm sorry. I can't possibly help you."

Huggins turned and looked at Dean Stanton. The Dean looked at Huggins. Then they both turned and looked at Doctor Rendell.

"Uh, could I have another of these excellent cocktails?" Doctor Rendell said.

"It was just terrible," Doctor Rendell said to Dot. "I thought that awful general was going to *eat* me." Remembering, he poured another jigger of whisky into his tea. "The worst thing was he didn't roar or threaten. Oh, Stanton did enough of that for both of them, but the general—all he did was smile a lot and

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go all squinty-eyed, and his voice got real quiet. I think he watched a lot of spaghetti westerns when he was a kid."

Dot was already three teacups to the wind and her faded green eyes were a bit blurry. She was cozy enough, however, wrapped in an old quilt, sitting on her loveseat across from him, nodding occasionally at the fire.

"Will there be any trouble, do you think?"

Rendell considered his glass. His wife was a bit of a problem. Her father had deserted the family when she was an infant. This background had imbued her with a horror of poverty, not at all alleviated by her late mother's adamant opposition to their marriage. "Marry a doctor. Better yet, a banker," had been her mother's advice, and Dot had never quite exorcised the admonition, even after forty years of academic comfort.

"Not if I stick to my guns," Rendell said. "I have tenure, after all. Nothing they can do. Although Dean Stanton did make some veiled threats. At least he thought they were veiled. Something about teaching bonehead English again." Arthur sighed. "The man is subtle as a cowpie in the face."

"Just be careful, Arthur. I know Dean Stanton's wife. She's an evil woman. Just like her husband, I suppose. Life is so often like that, you know."

"But Dot. I can't go along with it. You know how I feel about the arms race. It's madness. Remember when we were kids and I helped with the Vietnam protests? It's like that all over again. If people don't stand up . . . "

She swallowed a healthy glug of her tea. "But why must it be you? What difference can one man make?"

"One man can always make a difference," Rendell said stoutly. "In this case quite a lot, I expect. It's me they want, not anybody else."

Wordlessly she extended her teacup. Rendell poured without really looking. "We've had a good life, Arthur," she said at last. "Don't throw it away on one of your silly causes."

"Silly? But Dot—"

The doorbell rang.

"I'll get it," Rendell said.

Dot glanced at the ship's clock on the mantel. "Who could it be at this hour? Not one of your students, is it?"

Rendell had already risen. "Maybe it's Dean Stanton," he said. "Come to apologize."

"Fat chance," Dot said.

But it wasn't Dean Stanton. Doctor Rendell opened his front door and braced himself against an errant gust of wind. A young man smiled at him. He was wearing a neat suit beneath an open dark overcoat. He had blonde hair cut long, a hooked nose, and he was smiling. The smile wrinkled the corner of his brown eyes and Rendell saw his first impression of youth was a little in error. Not twenty-five or thirty, he revised. Closer to forty, in fact.

"Doctor Rendell?"

"Yes?"

"My name is Nikolai Podkorny. May I come in?"

The man spoke with a faint accent. Suddenly the name registered. "Of the Lenin Institute?" Rendell said.

The man nodded shyly.

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"Well, of course! Come in, Doctor Podkorny. What an honor!"

"Call me Nikki," Podkorny said as Rendell took his overcoat. "And the honor is mine, Doctor."

"Art, uh, Nikki. Or Arthur, whichever you prefer."

"I will call you Arthur, then," Nikki said.

"And I will get you a drink," Arthur said.

Dot, already thickly glazed, stayed just long enough for introductions before she excused herself to bed. The two men settled across from each other in front of the fire. Arthur dispensed with teacups. "Is whisky all right?" he said. "I don't have any vodka, I'm afraid."

"I hate vodka!" Nikki replied. "Besides, the Politburo has decreed vodka bad for the Soviet health. They didn't," he added with a twinkle, "say anything about whisky, however."

"Good, good." Rendell poured two healthy slugs. They raised their glasses in silent toast. "Well, Doctor Podkorny, I'm pleased to meet you at last. Your paper at the World Congress was a marvel, just a marvel."

Nikki tasted his drink and smiled warmly. "Thank you, Arthur. But it was a little thing, at least compared to your *Modern World*. That book! A hundred years from now my paper will be a footnote, but semanticians will still read *Principles of Semantics*. Why, in the Soviet Union, students mention your name in the same breath with Alfred Korzybski."

"They do?" Arthur said, pleased. "Of course that's silly. All of us moderns owe everything to the count."

Nikki shrugged. "Even if he was an aristocrat, and Polish at that. But it doesn't matter. Doctor, I couldn't wait. I was so excited I had to see you. Imagine. I will be working with the great Doctor Rendell!"

The Russian's enthusiasm was infectious. Almost, Arthur felt his determination waver. But a quick sip of Jack Daniels set him right again. "You mean this Starblaze thing?"

"Why, yes, Arthur. I am to be your liaison."

Rendell shook his head. "No," he said sadly. "I'm afraid you're not."

Nikki stared at him. "But what do you mean? You don't want to work with me?"

Arthur shook his head quickly. "No, not that. It's just that I am refusing to work on this project at all. I won't take the grant. It's against my principles."

Nikki reached for the bottle and filled both their glasses to the rim. "The Persians used to believe no decision should be made before considering it fully, both drunk and sober." He pushed the cork back in, but left the bottle within easy reach. "It seems like a Russian sentiment as well. What do you think, Arthur?"

"Well, I suppose."

"Tell me again what your role will be," Arthur said.

The fire had burned to a dim orange glow which barely illuminated the nearly empty bottle of Jack Daniels on the coffee table. Nikki's tie was on his sportcoat, and both were on the floor. Both men had their sock feet on the table.

"It's the safeguards," Nikki said. He ran his fingers through his hair. "This

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nanotechnology, your country is so far ahead of mine. You have progressed to the engineering phase. You can build the gadgets. But we aren't hopelessly behind, and we will catch up. So your president proposed to my premier a compromise." He fumbled for his glass. "Compromise. It's wonderful, isn't it?"

"Wonderful," Arthur agreed, raising his own glass vaguely.

"Your scientists are sharing information with ours, so we may be assured your system is purely defensive. Not all the secrets, of course, nobody would be so stupid, but enough. Nobody wants a war, Arthur. So I am here, and I am to work with you."

"Nikki, doesn't that strike you as a bit crazy? I mean here you are, helping to build weapons which could be used against your own people."

"Not against my people, Arthur. That's the whole point. Starblaze is to operate against missiles only. Against a nuclear attack. And of course the Soviet Union, a peace-loving nation, would never launch such an attack. Unless," he added darkly, "some other nation were treacherous enough to deploy a weapons system with first strike capability against us. Then, of course, we would have to do something." He paused, then brightened. "But nobody would do that. Certainly not the United States of America. Especially under our monitoring agreement."

The details were beginning to slip away from Arthur. This nanotechnology, these molecular machines that seemed such an integral part of the Starblaze system, he didn't really understand at all. But now he detected an undercurrent in Nikki's words that, despite the Russian's charming friendliness, was alarming.

"Nikki, pardon me, but are you making some kind of threat?"

"Threat, Arthur? We are friends. Friends don't make threats. But certainly we would be, ah, worried. Yes, worried, if so eminent a man as yourself were left out of the monitoring process. Perhaps to do his work in secret. Yes, that might worry us."

"But Nikki, I have no intention of doing any work at all. I already told you that."

"Ah, yes. But how could we be sure? That is the question, Arthur. How could we be sure?"

Arthur woke with a pounding headache and a mouth like the Gobi Desert before reclamation.

"Serves you right," Dot said at the breakfast table. "Two empty bottles and . . . Arthur?"

"Mmmph?"

"You left your socks on the coffee table."

Arthur moaned softly. "More coffee, please," he said. "And do we have any aspirin?"

A moment later she plunked the bottle down next to his coffee, making far more noise than was needful. He winced.

"Something else," she said. "Dean Stanton's secretary called. He'd like to see you as soon as you get in."

Arthur swallowed the aspirin dry.

"Do you know what this is?" Dean Stanton lifted a sheaf of legal sized papers from his desk. "Art, are you lis-

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tening to me? What's the matter with you? You look terrible."

"Flu," Rendell said numbly. "Just a touch."

"Well, I hope you feel better soon. Anyway, look at me. These papers, you know what they are?"

Arthur shook his head and wished he hadn't. "No. What are they?"

Now Stanton's bulldog features took on a sly cast. "Well, Art, about your house. You remember when you bought it?"

What was the man getting at? "Of course," Arthur said. "Fifteen years ago."

"That's right. Through the faculty loan program. These papers are the note. You know, I was just reading through them this morning. You have six years to go. And, of course, there is clause thirteen. The university has title to your house. And it can call the loan at any time."

"Dean, whatever in the world are you talking about?"

Stanton was smiling openly now. "For the good of the university, you know. Of course, if we did call the loan, you might be able to refinance with a local bank. Although you should consider that most of the bankers around here sit on the board."

The point of this performance finally wormed its way through Arthur's painful fog and he sat up straight. "Wait a minute, Dean. Are you—I mean, this sounds awfully like blackmail, pure and simple."

Stanton nodded thoughtfully. "For the good of the university, Arthur," he repeated. Then his voice went cold. "And blackmail's such a threatening word, don't you think? I prefer to call it hardball."

"Hardball," Arthur said helplessly.

"But it's my principles at stake," Arthur said.

"It's our house at stake," Dot replied. Her eyes were red-rimmed and weepy, and she'd already had too much Jack Daniels.

Suddenly, she burst into tears.

"Now, Dot. Now, old girl." Awkwardly he reached across and patted her hand. It seemed his choices were quite clear-cut. He could accept the grant and work with the nice Doctor Podkorny, who assured him that the real goal of Project Starblaze was peace. Or he could refuse, have his academic life turn miserable, and possibly even lose his house. Not to mention what it would do to Dot.

At his touch her wails grew less intense. "There, there," he said. "I'll think of something."

But as he listened to his wife sob quietly he felt disheartened and sick. And though he despised Dean Stanton, he knew that pompous little man had not dreamed up his threats by himself. No, the fine hand of General Huggins was inside Dean Stanton's iron glove, and for the first time in his life Arthur felt the stirrings of real hatred for another man.

"Arthur, believe me," Nikki said, "this is all for the best." The Russian gestured at Rendell's spacious office. "And isn't this wonderful? All this room, and you don't even have to share a secretary."

"I could have kept my old office,"

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Arthur said grumpily. "And if they were going to get me a secretary, why not one of those young pretty ones? Not some pipsqueak air force lieutenant."

Nikki smiled. "You'll get used to it. They tell me Lieutenant Scithers is quite efficient. Well-educated. He doesn't even wear a uniform. Although I have to admit his taste in sports coats is quite deplorable."

Arthur sighed. "I suppose," he said. "They say you can get used to anything. And I guess this isn't a prison."

"Prison? Who said anything about prison? This is America, Arthur. The land of the free."

Arthur stared at him. "Remember what we teach the new students about semantics, Nikki? I suppose you have something like it. You know, which would you rather have? A chunk of seared, nearly raw muscle from a castrated bull, or a nice, medium rare filet mignon?" He shook his head. "It's not a prison. But it isn't freedom, either."

"OK, explain this connection to me," Arthur said. Nikki was poring over a sheet of hard copy, his brow furrowed. He looked up.

"See here, Arthur? It's these new nanocomputers. Far faster and more intelligent that anything ever built before. And with their synthetic diamond housing, about the size of a teacup. That's the problem. The artificial intelligence programming."

"Yes, yes, you've explained that. They had to come up with an entirely new language to operate them. But how does semantics enter in?"

"Remember your example of the steak? To previous machines there would have been no emotional value given either description. You could have told those machines either thing and they would have accepted both equally. But these new machines are capable of far finer distinctions. Almost emotions. It has something to do with electron levels in the high-temp superconducting material, I think. Anyway, the words have assumed terrible importance. We have to vet everything in semantical terms. Otherwise the programmers might make errors. And when we're dealing with a system as powerful as Starblaze, there can be no errors. Too much is at stake for both our countries."

Arthur nodded. Again he caught the undercurrent of threat. Too much at stake. Both our countries. For the first time he realized the delicacy of the project he'd undertaken. Unless the Soviets were convinced that Starblaze was harmless to them without a first strike on their part, god only knew what they might do. And it was such a sacrifice on their part to be cooperating in the first place. He imagined they had generals fully as ruthless as General Huggins.

"Nikki, why are your people going along with this?"

Podkorny shrugged. "I told you. Your scientists were so far ahead. Our choices were limited. Either we accepted your president's offer, or we exercised a far more horrible option. This nanotechnology is like any other new science. Once the cat's out of the bag, you can't put it back in. Your country will go ahead whatever we do. Or we will. Or somebody will. This is our best chance, Arthur. Perhaps our only one."

Nikki's face was cold and serious,

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and Arthur was suddenly frightened for himself. For Dot. Even for Nikki. Even, god help him, for Dean Stanton. He'd been given rough parameters for the Starblaze. Tiny nanocomputers, clusters of molecular machines only a micron in diameter, operated equally small builder machines called replicators and assemblers. Properly programmed, these incredibly small marvels could create almost anything, a molecule at a time. All they needed were raw materials. Plans called for the heart of the system to reside on the Moon, an endless storehouse of basic elements. And it would only take a single launch.

Dimly he sensed that a force potentially far more ghastly than atomic weapons was loose in the world. And he was helping to shape it. What, he thought despairingly, had he come to?

"We call it an active shield," General Huggins said.

Rendell tried to pay attention. Several newer members of the programming team were gathered in conference room C for what the general called a basic briefing.

"Starblaze—" The general thwacked a large viewscreen behind him with a pointer—"can sense an enemy attack as opposed to an accidental launch, decide what sort of defense to use, and deploy that defense, all in the blink of an eye."

One of the younger programmers raised his hand. "How does Starblaze counter an attack, General? I've seen estimates that the Sovs might launch as many as two thousand missiles in a full blown first strike. Even from subs a few miles off our coast."

The general grinned. His eyes glittered. "Why, son, Starblaze uses everything. Gigawatt lazers. Hypermissiles only a couple of meters long. Even rocks, if that is called for. Don't worry. If something nasty sticks its head up, Starblaze can swat it."

The programmer shifted uncomfortably. "Sounds like an awful lot of weaponry up there."

The general speared him with a hard blue glance. "Freedom requires a lot of protection, son. And this is the ultimate protection. You better believe anybody stupid enough to attack America with Starblaze in place is going to regret it."

The programmer nodded. "Lose all their missiles right there," he said.

The general tapped his palm with the edge of the pointer. "Lose more than that," he snapped.

"Huh?"

"Nanotechnology makes building nukes real easy and real cheap," the general replied. "Any attacker will live to regret it. Well, live a little while, at least." He chuckled harshly. "Of course, we hope we'll never have to use that option."

The programmer seemed shaken. "Of course," he replied softly.

Rendell felt sick.

"The programming is the key to the system," Nikki said. "All the rest is hardware, no matter how fancy or powerful. But the computers tell it what to do. That's where I come in. Your mad dog general has to satisfy me the programming doesn't have any ugly little surprises. The agreement between our nations is quite specific. Starblaze is to be a defensive system only. It must have

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no capability for attack whatsoever. If it does . . . " His voice trailed off. Rendell recalled the vicious light that had danced in General Huggins's eyes at the briefing.

"Did you ever go to one of Huggins's information seminars?" he asked.

"You mean the one where he rants about nukes and all that? Sure, I've been. We let him play his little games. Of course it's all hot air. Starblaze is designed—has to be designed—so it can't attack passive targets under any circumstances. Even in a war. If it is anything else, then all bets are off," Nikki said grimly.

Arthur regarded him silently.

"But it's just the general mouthing off. They're all alike, generals. Ours are just like yours. Sometimes I wish we could shoot all of them to the Moon. Without suits."

Rendell nodded. "But you can't," he said. "The generals will always be with us. Always."

"Then we must be vigilant, eh, Arthur? We men of peace must be eternally vigilant."

The feeling of disaster that had been gestating in Arthur's gut reached the explosion point three days later. Huggins came to his house in the evening after the dinner hour.

"Why don't you watch TV in the bedroom?" Arthur said to Dot. "General, sit down."

Arthur didn't offer him a drink. The general didn't seem to notice. He merely sat on the loveseat and waited, his back stiff, until Dot left the room.

"What is it, General?"

"I'll come right to the point, Rendell," the general said. As he listened to the soft voice, Arthur thought of hissing reptiles, small things with teeth and slow moving, viscous blood.

"Please do," Arthur said coldly.

"We've been quite satisfied with your work. Quite satisfied. But now we have to ask you for something greater."

With a sinking feeling, Arthur nodded. He could almost guess what was coming next. "Go on," he said.

"Mm. Yes. Tell me, Doctor, would you say that Doctor Podkorny is your equal?"

The question startled Arthur. "What? I don't know what you mean. As smart as I am? Probably. No doubt about it, in fact."

Huggins shook his big head in irritation. "No, I don't mean that. Your professional equal. What I'm saying is, does the Russian understand entirely what you are doing? Could you pass something by him, in other words, without his realizing it?"

Give the devil an inch, Arthur thought suddenly, and he'll eat your feet. But he knew precisely what the general was after.

"You mean could I modify the programming of Starblaze so that it could be used as an offensive system?"

The general regarded him a long moment. Then, "Yes," he said. "That's what I mean."

The crunch had finally come. Arthur hoped he was ready for it. One man against the system. He straightened his back and took a deep breath. "I won't lie to you, general. Nikki is good, but no match for me. I could do what you want. But I won't."

* * *

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The next week was hell. Dean Stanton called him in twice, but all Arthur would say was, "Go ahead. Take my house. I won't be a party to this."

Dot cried almost constantly. The only time she was quiet was when the whisky carried her off to restless, sweaty sleep.

Only Nikki remained cheerful. But then, he didn't know what was going on. Occasionally Arthur thought about telling him, but he always stopped. Would that put Nikki in danger? He had no doubt General Huggins could arrange an "accidental" death in order to preserve his aims. And then there was Nikki himself. He seemed a wonderful fellow, but he was a citizen of the Soviet Union. Ostensibly the enemy, and Rendell, near-pacifist that he was, was not so starry-eyed that he thought the Sovs were all sweetness and light. Certainly not their generals. In a way he was glad that if this technology had to be developed it was being done in his own country. He doubted the Soviet military would be as shackled with safegurads as his own was.

And the thought of treason, even in the name of peace, was an ugly one. At bottom, Arthur Rendell loved his country.

But what to do? That was the question. What could one man do?

He didn't figure it out for another three days.

A winter snowstorm was howling down out of Minnesota on the day he marched into General Huggins's office. The general looked up from some papers on his desk. "Yes?" he said. The word was as frigid as the storm outside.

Arthur took a deep breath. "General, this has got to stop. It's over. Now."

"What are you talking about?"

"I won't do what you want. It's terrible. And I've given it some thought. What you propose can't be legal. It violates everything I've heard about the Agreement. The more I considered it, the more I realized it must be your idea. I can't imagine why you want to do it. You probably think, in your jackboot little mind, that it's some kind of patriotism. Well, it isn't. And if you pressure me further, I will report this to your superiors." He paused. "Please don't think you can threaten me. I've already arranged for a report of all this to go to other people if something should happen to me."

Throughout Rendell's speech the general sat absolutely still, his face a stone.

Rendell stopped. The general smiled. "Finished?" he said.

"Well, uh, yes." He'd expected, at the very least, an explosion, more threats until the general finally saw the light. The quiet question left him nonplussed and uneasy.

"I wondered when you would figure out something like this. Very good, Doctor. You're ahead of schedule, and you are absolutely right. My superiors would have my balls if they knew what I was planning."

Rendell exhaled slowly. "You mean you agree? You won't bother me any more?"

Now the general smiled ferociously. "Of course I will, you silly man. My superiors are a bunch of weak idiots, but that doesn't mean a true patriot still can't get things done. One man can

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make a difference, Doctor. And I am that man. There is no way in heaven or hell that I will pass up this chance. America is the greatest nation on Earth. I intend to keep her that way."

Arthur felt weak and light-headed. "That's it, then. I will report you to your superiors. Today. And it will be over. You are a sick man, General. I feel sorry for you."

"Save your pity!" the general barked. Suddenly he laughed. The sound was bitter. "And no, you won't report anything. Want to know why?"

Rendell stared at him, a rabbit mesmerized by a snake beyond imagining.

"Because nobody will believe you," the general went on. "I know all about your pinko past, Rendell. Why do you think I put you in with that commie? And your drunken wife. You think anybody will take your word over mine? What proof do you have? Only what will be considered your paranoid suspicions."

He leaned back in his chair and folded his hands over his stomach. "No, Doctor," he continued, in a softer tone of voice, "report away. It won't do you any good." He chuckled softly. "And now, since we've got that out of the way, here's some things for you to consider. I know what Dean Stanton told you about your house. That's only the beginning. Worse things can happen. For instance, your wife is an alcoholic. Perhaps she's even insane. I bet I could get a special order, run it through the CIA, to have her committed. After all, a person like that—why she probably interferes with your very important work. National security. The courts don't even enter in. The CIA has several places for people like her. Some are nice enough. And some . . . aren't. So what do you think of that, you goddamn pinko traitor?"

Arthur felt the room lurch sickeningly. He was barely able to keep his balance. Blindly he reached out and grabbed the doorjamb. All he could see was Huggins's craggy, evil face, smiling and smiling.

Could this be happening to him? Of course it could. It was happening now. He said the first words that popped into his head.

"You've been spying on us."

The general spread his hands. "Too harsh a word. It is my duty to monitor the health and safety of my personnel. Which is what you are, Doctor. *My* personnel. And you do whatever I tell you to. Is that clear?"

"But . . . what . . . I—"

"Is that clear?"

Arthur's knees felt weak as gelatin, but he would not allow himself to fall. Not in front of this monster.

"Yes," he said at last, and was surprised to find his voice steady. Thick with loathing, but steady. "Perfectly clear."

What followed was a blur. Arthur worked harder than he had ever worked in his life. It was so difficult keeping it all bottled inside, smiling and working with Nikki as if nothing was wrong.

But he did it. Occasionally he thought about his theory that one man could make a difference. He wondered if it had ever been true. But then he considered General Huggins. He was one man, and if he succeeded, he would have made a difference. Perhaps the greatest

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difference in the history of the human race.

One day he came into the office to find Nikki waiting for him, a worried look on his face. "Arthur, is something wrong?"

Rendell waved one hand vaguely. "Oh, you know. The work is getting to me. We're at a critical juncture right now."

"I know," Nikki agreed. "I've never seen anybody do better stuff than you, Arthur. I respected you before. But now—well, this sounds sophomoric, but I think I'm in awe of you."

"Oh, don't be silly. And don't worry. I'll be fine."

Nikki looked doubtful. "Well, if you're sure. But if I can help some way . . . "

Arthur shook his head testily. "Help? Of course you can. Just keep up your end. Have you got the new semantic equations?"

Podkorny brightened. He waved a sheaf of printouts. "Just back from the computer. And so elegant! Who could have conceived such a twist on the old 'x, not-x' theorem but you?"

"Nikki, you're irrepressible. And thank you for the compliment."

"It's perfect," Nikki said. "You've created a new language for the new machines, using nothing but the shadings between x and not-x. And thus you give the language nearly infinite power. Starblaze will have a magnificent brain."

"Give me those printouts," Rendell said tiredly. But he was smiling. Because he saw a way out.

An armed sergeant came for him. Huggins had been gone a week, one of the party from the university attending the launch. The papers were full of it. Arthur had waited and wondered. The presence of an armed guard gave him all the answers he needed.

Huggins would not allow him to sit. "You're under arrest, Doctor. Did you think I wouldn't figure out it was you?"

Arthur shrugged. "No."

"What did you do, anyway? My people are still trying to figure it out. Everything worked perfectly, right up to the lunar landing. But when we sent the activation signal, Starblaze went into full defensive mode. Its shields are up, it won't accept any of our instructions, and it has full self-protection modules already deployed. Other monitors indicate it's already churning out hundreds of hunter-seeker units. How long will that go on?"

"Forever," Doctor Rendell said.

"Pity. You probably think you've won, Doctor. Is that correct?"

"At least you won't be able to use it as a weapon," Rendell said. His voice was mild. "You outsmarted yourself, Huggins. If I could fool a man as smart as Nikki, you should have realized your own technicians would be child's play."

The general ground his teeth in frustration. The sound was clearly audible in the quiet room. "Doctor, you're a traitor to your country!"

The old man shrugged. "Perhaps."

General Huggins glared at him. "You'll pay. But so will your commie friends. We tested Starblaze before it went on lockout. It worked!"

"Of course," Doctor Rendell said calmly. "And it still does."

The general sagged with relief. "You didn't screw that up, then? Thank God!

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It means we still have the upper hand. I win after all." Huggins's eyes bulged with triumph. "Even if we can't use it as a weapon, Starblaze will still shoot down any missile they launch. The Sovs are helpless."

"Yes," Rendell agreed. "It was a good piece of work, if I do say so myself."

Huggins heard the odd note in Rendell's voice. He stared at him with growing unease. "Am I missing something?" he said finally.

Arthur Rendell smiled with peculiar sweetness. "No, not at all. Starblaze will shoot down any missile."

"I understand," Huggins said impatiently. "So why do you seem so calm? I'd think you'd be frothing at the mouth. After all, I'm going to destroy you for what you've done, you filthy traitor."

"I think not," Arthur said. "You see, the Soviets know of your little trick. I told Nikki before he left. Three days ago. He's safely back in the Soviet Union now. Your superiors might not believe me, but I think they'll listen to the premier of the U.S.S.R."

A crack appeared in the facade of General Huggins's expression. Slowly, the color drained from his face. "What have you done?" he asked with growing horror.

"What's right," Doctor Rendell said. "And there's one other item. You see, you stupid son of a bitch, I forgot to tell Starblaze not to shoot down our missiles, too. Now *that's* an active shield."

General Huggins's mouth sagged open.

"You were right about one thing, though, General. Maybe the only thing you and I agree on."

"What's that?" the General asked. His skin was the color of ashes.

"One man *can* make a difference," Doctor Rendell said. "And that's what *I* call hardball." ■

●We changed with the times, so we can't blame the children for just joining the times, without even having to change.

Will Rogers

●People, like sheep, tend to follow a leader—occasionally in the right direction.

Alexander Chase

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Click.

A mechanical sound. A relay, perhaps. A flip-flop switch or maybe a butterfly valve. Very soft. Almost muffled.

Sigh.

And that was hydraulics. Escape gas bleeding off. Pressure relief. Again, a muted sound, not particularly obtrusive.

Click.

It was a metronome. A syncopation. If you focused all your attention on it, it could become—

Sigh.

—quite relaxing. Hypnotic even. It would be easy to lose oneself in its rhythm.

Click!

The sudden hand on his shoulder made him start.

"Mr. Carter?"

Sigh.

He turned, unwilling; guided by the gentle but persistent pressure of the hand on his shoulder. His vision rotated, camera-like. Away from the equipment; along the tubing, hanging in catenary loops; past the blinking monitors; toward the sight that he had been avoiding ever since he had stepped into the room.

Click.

"Yes, Doctor?" His voice was listless, uninterested. He heard it as if he were a spectator at a very bad play.

"We did all we could, Mr. Carter. The medics stabilized her as soon as the police cut her out of the car. But I'm afraid there was little else they could do."

Sigh.

He looked at the doctor, turning his head quickly, so that the bed itself flicked across his vision without registering. But his subconscious saw the subliminal afterimage and began sending messages of pain and fear.

Click.

"I understand, Doctor. . . ." He glanced at the name tag pinned to the white uniform, trying not to notice the little splashes of red on the sleeves and on the chest. "I understand, Doctor Lapointe. I'm sure you did everything possible."

"If we had gotten to her sooner, or if the trauma had been less severe, we might have been able to repair the damage. There have been incredible advances in tissue repair nanomachines in the last several years. . . ."

Sigh.

Henry Norris Carter wondered if the doctor thought he was being comforting. Tell me more, he thought. Tell me all the different ways you might have saved her. If only. If only this advance had been made; if only that had been done sooner. If only. If only.

Well, take it as he meant it. "Yes, Doctor Lapointe, but I'm sure you understand that such speculations cannot make me feel any better about what's happened." (And a part of his mind curled up and gibbered, *Nothing's happened! Nothing's happened!*) "I'm quite aware of the advances in nanotechnology. My wife and I both work—" He suddenly realized he had used the present tense and stopped, confused. "—no, worked—" But that wasn't right, either. Not yet. "I mean we were both genetic engineers at SingerLabs over in New Jersey. We both donated DNA to the cell library there. As long as we're talking 'if only's,' if only I had her cell samples with me—"

"No, Mr. Carter, you mustn't think

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that. As I said, the trauma was too severe. Even the most advanced nanomachines are still too slow to have saved your wife before irreversible brain damage set in."

So. Finally. He forced himself to look directly at the figure on the bed. The maze of tubing crawled snake-like around it. Encircling it; binding it; piercing it. Up nose. Down throat. Into vein and groin. Pushing the fluids and the gasses in and sucking them out, because the body itself had given up the task. The click/sigh of the respirator faded into the background.

The contours of the sheet were not quite right; as if parts of what was under it were missing. The doctors, he supposed, had cobbled the body back together as best they could, but their hearts hadn't been entirely in it. The whole left side of her face was an ugly purple bruise. And the symmetry of her nose and cheekbones and jaw was irretrievably lost. The right eye was closed, as if sleeping; and the left— The left eye was hidden under a mass of bandages. *If it's there at all.* Judging by the extent of the damage on that side, it was doubtful that the eye had remained in its socket.

He wanted to scream and his stomach gave a queer flip-flop and his knees felt suddenly weak. He trembled all over. Don't think about that. Think about anything else. Think about—

Quiet evenings at home. She, reading her favorite Tennyson in a circle of soft light cast by the goose-neck lamp; while he pretended to read, but watched her secretly over the lip of his book and she knew he was watching her and was waiting for just the right moment to —

Running through the rainstorm down 82nd Street from the Met, his trenchcoat an umbrella over both their heads. Laughing because it was so silly to get caught unprepared like that and they were soaked to the skin already and—

Hiking the Appalachian Trail where it lost itself in the granite mountains of New England and stopping to examine the wildflowers by the edge of the path and wondering why on earth the stems would always branch in just exactly that way and—

Four-wheeling over Red Cone that summer in Colorado and how he had froze at the wheel because all he could see out either side of the Bronco was sky because the road ran up a ridge only a little wider than the car itself and how could anyone expect to drive over a knob of rock that steep? And how the sign on the other side, by Montezuma, had said dangerous road travel at your own risk and wasn't that a hell of a place to put it and—

Her eyes had been a most lovely shade of hazel.

"Pardon me?"

Henry looked at the doctor and blinked away the memories that had blurred his vision. "I said her eyes were hazel."

"Oh."

He turned and looked again at his wife. The doctor seemed at a loss for what to say and for a crazy instant Henry felt sorry for *him*. The doctor wanted to say something, anything to pierce Henry's shell of misery; but there was nothing that anyone could ever say or do that would make the slightest particle of difference in how he felt.

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He felt. . . . Nothing. He was numb. He refused to accept what he saw.

"Barbara."

"She can't hear you. She's far too deep in coma for that."

He ignored the doctor's comment. It was patently absurd. Voices made sound waves; and soundwaves vibrated eardrums; and eardrums made nerve impulses; and somewhere, somewhere deep inside that dying body there had to be a tiny, glimmering spark, wondering why everything was growing so much dimmer and fainter, and he would be *damned* before he let that spark flicker out all alone in silence.

He drifted toward the bed; and the doctor, sensing his intention, guided him toward her relatively uninjured right side. The doctor lifted the sheet, exposing her hand and Carter took it in both of his. He noticed the mole on her right side, just above the curve of the hip, and touched it briefly with his forefinger.

"The other driver," the doctor said, "the one who ran the red light, was killed instantly. An eighteen-year-old kid and dead drunk. Now he's just dead."

Henry shook his head. Did the doctor think that that thought would comfort him? He felt a brief regret that the drunk hadn't suffered; and a second regret that he would wish such a thing of anyone; and then he felt nothing once more.

"Barbry, I'm here. I came as soon as they called." He stroked her hand gently, fingertips on palm, and let his palm run under her limp fingertips; and was embarrassed to notice how his body, for a brief instant, responded to the remembered touch.

He began telling her about his day, because there wasn't much of anything else he could think of to talk about. (And why had she taken the day off to shop for his birthday? They should have been together in the lab, safe. Instead—)

Instead, he told her how he and Bill Canazetti had finally made some progress on the Barnsleyformer; because the trick wasn't in the morphogenesis after all, but in the fractal geometry of the genes. They had gotten a brief, tantalizing glimpse of a simple and elegant recursion formula and would have continued to work on it well after quitting time except the phone call had come from the hospital and—

And the traffic at the tunnel ramp had been terrible. Backed up all the way around halfway to the turnpike gate. Wasn't it always that way when you were in a hurry?

At any rate, he told her, 'Dolph Kavin was doing a slow burn because he'd been passed over for project leader on the cloning team. Old Lady Peeler had picked Amanda Jacobs and 'Dolph had complained bitterly to anyone who would listen (and there weren't that many) how women always stuck together; but you know how it is with office politics. And he said it was probably a lot different in the old days before Singer had died and the Lab was run on a more personal level.

And—

"She's gone, Mr. Carter."

He jerked for the second time at the unexpected touch; and looked from the hand tentatively laid on his wrist, up the arm to the doctor's sympathetic face.

"What?"

"She's gone. All brain activity has

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ceased. I—" He broke off, looked uncomfortable, mustered his resolve. "If you would sign a few forms, please. Many of her organs can still be saved, if we act quickly." The doctor looked at him in mute appeal. Your wife is dead, his eyes seemed to say; but we can still save others if you help.

Others.

Strangers.

And why should he care about strangers?

Donate organs. A nice way of saying, let's cut up your wife's body into little chunks and sew them into other people. Intellectually, he and Barbara had always supported the organ donor movement; but it was different when the actual time came. And what the hell did it matter? Barbry didn't live there any more.

"Yes," he said; and his voice came out in a sort of croak. "Yes," he repeated. "Go ahead. It's what she would have wanted."

"You're doing the right thing," the doctor assured him. "Your wife may be dead, but part of her will go on living through others."

Click.

The most awful thing about the whole business, Henry decided as he rose shakily from the chair, was the way the respirator continued to pump air and the way in which the sheets continued to rise and fall. As if the person beneath them had only fallen into a deep slumber and would awaken when the morning came.

Sigh.

Of course, they insisted that he stay and rest. They gave him a mild sedative and they made him lie down for an hour or so. He closed his eyes, but his mind wouldn't shut down. It kept spinning and spinning, trying to find a way out of accepting what had happened. When he arose only a short while later, he was unrested and unrefreshed.

It was the early morning pre-dawn hours when he left Roosevelt Hospital and made his way down Ninth Avenue toward the Lincoln Tunnel entrances. There was a mist off the Hudson that gave the West Side a ghostly and unreal appearance. Sounds echoed as if on a damp and abandoned stage set. His was the only car on Ninth Avenue and in the distance a single pair of headlights drifted crosstown. If New York was The City That Never Slept, during these hours it at least dozed fitfully.

Some part of him had taken over from the gibbering, helpless personality crouching in the back of his head. It was a part of him that felt nothing and thought nothing. It was an automaton that made his body do all the right things, like some faithful robot dutifully carrying home its injured master.

The neighborhood north of the tunnel ramps had once been called Hell's Kitchen; but the new yuppy-fied city was a little ashamed of its rough-necked, blue-collar past, so they called it Chelsea North now. They could call it what they damn well pleased, but some things never change. It was still Hell's Kitchen and if the police no longer walked the beat in squads of five as they once did, it was because they seldom left their patrol cars.

If Henry had been entirely himself, he would never have made the wrong turn. But automatons do make mistakes

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and the sign with the arrow pointing toward the tunnel was placed ambiguously. He meant to turn right at the *next* corner; but his eyes saw the sign and his hands spun the wheel, and there he was.

He realized his error almost immediately. He cursed for a moment or two and checked the street sign at the next intersection to get his bearings. He turned, and turned again, and then he saw her.

The streetlight was a stage spot highlighting a tableau. Brown, ratted hair hanging low around familiar eyes and nose; her body wrapped in a tattered pea jacket, and huddled over a heating grate; hugging a tattered shopping bag to her. Three men—two black, one white—loomed over her, laughing, giving her little shoves, while her eyes darted like mice eyes back and forth, looking for escape.

"Barbry!"

Henry hit the brakes, twisted and grabbed the jack handle from the floor in the back. He burst from the car. "You! You, there! Leave that woman alone!"

The men laughed and turned on him and the laughter died. If Henry had been entirely himself, they would have pounced without a thought, like any wolf pack. But he was not entirely himself, and he had a jack handle in his hand, and there was something in his eyes. A flame. They used to call it the berserker look. It was the look that said that, whatever came, life or death, he would accept it gladly.

The three liked long odds in their favor. Three strong young males against a lone woman, that was acceptable. But against a crazy man with the berserker look? No. You couldn't win against a man who didn't give a damn. They might walk out of it, but maybe not all three, and certainly not all whole. So they sought the better part and walked away, throwing obscene words and gestures after them to show they hadn't been afraid after all, not really.

Henry walked to the woman on the grate and took her by the hands and raised her to her feet. She looked at him with fear in her eyes.

"Barbry?"

And she didn't really look like Barbara at all, and that broke the spell. Henry blinked and his surroundings came crashing down around him. Hell's Kitchen? My God! How had he gotten here? He could remember nothing since lying down at the hospital. And who was this woman?

She looked like— But, no. Her hair was brown, like Barbara's; but it was a shade darker. The face had the same shape; but the cheekbones sat lower. And there was a scar that ran from under the right eye, across the cheek toward the ear. She stank: of sweat and booze and excrement. Whoever it was, it wasn't Barbara. And why on earth would he ever have thought that?

"Who are you?" he asked.

She didn't answer and tried to pull her hands from his. Henry remembered leaping from the car, and looked around with sudden alarm. Those three punks might come back any moment. He began to shake as he realized what he had done.

He turned back to his car, remembered the woman, and hesitated. He couldn't just drive off and leave her here. If those punks came back, she'd

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be worse off than if he had never stopped.

"Come on," he said. "Get in the car."

She looked at him doubtfully and backed away a step, holding her shopping bag like Hector's shield. Henry pulled open the passenger's door. "Get in," he repeated. "They might come back."

That seemed to get through to her. She glanced down the street in the direction her tormentors had gone, then looked back at Henry's Town Car. Her tongue swept out and around her lips. She looked at him again. Then she made up her mind and darted into the safety of the automobile.

Henry slammed the door, ran around to the driver's side, and slid behind the wheel. He hit the door lock and all four doors snapped at once. The sound startled the woman who jerked around anxiously. She tried the door and it wouldn't open; so she slid across the seat from him as far as she could go, putting her bag between them and clutching it to her.

He took her with him back to Short Hills because he didn't know what else to do and it was easier to make no decisions than to decide anything. Once home, he hustled her inside his house, glancing over his shoulder while he did so, to see if—despite the hour—any of the neighbors were watching.

In the kitchen, she pulled away from him and ran to the farthest corner and crouched there, making small sounds in her throat. Henry wondered how much human being was left imprisoned within her skull. There but for the grace of God. . . . Barbry and this bag lady looked somewhat alike, enough to be taken for sisters if not for twins; yet, Barbry had lived here, in comfort if not in luxury, while this woman had lived on a heating vent in Hell's Kitchen. How easily it might have happened the other way. What trauma might have been enough?

"Now that I've got you," Henry told the woman, "what do I do with you?"

She seemed to shrink within himself and Henry held out what he meant to be placating hands. "Don't worry. I won't hurt you. If you want, you can have a shower and a meal. And a change of clothes." The thought of giving this woman one of Barbry's dresses was distressing. He wasn't ready to part with anything of hers, not yet. But there was a trunk in the attic, with some cast-offs that she had meant to donate to charity anyway.

He took the bag lady by the hand, noticing as he did so the track of needlemarks up the inside of her arm, and showed her the shower in the bathroom. He gave her a washrag and towels and one of Barbara's old housecoats and told her to leave her dirty clothing for disposal. The woman glared at him suspiciously, so he shrugged and walked away.

In the kitchen, he opened a can of beef broth into a pot and turned on the heat. Something not too taxing for her system. As the odor filled the room he realized he was hungry, too, and he added a second can to the pot. After it had come to a boil, he reduced the heat to simmer and walked to the kitchen window.

The kitchen faced on a woods pro-

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tected by "greenbelt" legislation from development. No danger of ticky-tacking working class homes depressing the property values. The canopy of the trees looked like a silhouette cut from black construction paper, the false dawn providing an eerie backlighting.

He still didn't know her name. He had asked twice on the drive back, but she had remained silent, staring at him with ferret eyes, and he began to wonder if she even realized what was happening to her. Probably not much intelligence left. Etched away by years on the streets and a constant drip-drip-drip of heroin on the brain cells. Odd, how much—and how little—she looked like Bar— Like Barb—

He squeezed his eyes shut and willed himself not to think of her. The sound of her voice. A wisp of perfume. Remembered kisses.

After a while, he realized that he couldn't hear the shower running upstairs. What was that bag lady doing?

When he checked the bathroom she wasn't there, so he searched from room to room until he found her. She was hiding in the closet in the guest bedroom. She had taken the few odd garments hanging there and made a sort of nest of them. The wire hangers swung and tinkled like Japanese wind chimes. She looked at him with those ferret eyes; expecting anything, surprised at nothing.

Somewhere, she had found an old bag of salted peanuts. A relic of some airline flight Henry had long forgotten. She had poured the nuts into her palm and was gnawing at them. When she saw Henry at the closet door, she clutched the foil bag to her, as if she expected him to try to take it away.

Eventually, she did eat. Not the peanut bag, but the soup Henry had prepared. She wolfed it in greedy gulps, her left arm encirling the bowl, and her right wielding the soup spoon like a shovel. She kept her eye fixed warily on him the whole time, except when she darted quick looks around her, like an animal guarding its prey.

When she was done he took the bowl, which she released only reluctantly; and this time when he led her to the shower she seemed to understand. She grabbed the towels from his hands and stared at them. Then she stared at him.

"Go on," he said gruffly. "You shower now. I'll go up to the attic and see if I can find some old clothes for you."

When he returned from the attic with an armful of clothing, Henry found the woman in the library, sitting in Barbry's favorite reading chair. Showered and scrubbed, she seemed like a different person. Certainly, she smelled different: fresh and clean. From the rear, in the soft light and wearing Barbry's bathrobe, she looked enough like Barbara to make Henry's heart freeze for a moment. The dresses fell from his arms and he braced himself against the back of his own reading chair.

And the illusion vanished. All he saw was a bag lady holding the portrait photograph that Barbara and he had had taken only eight months before.

"That was my wife," he said, and she jumped a little and turned and looked at him. Her eyes were childlike.

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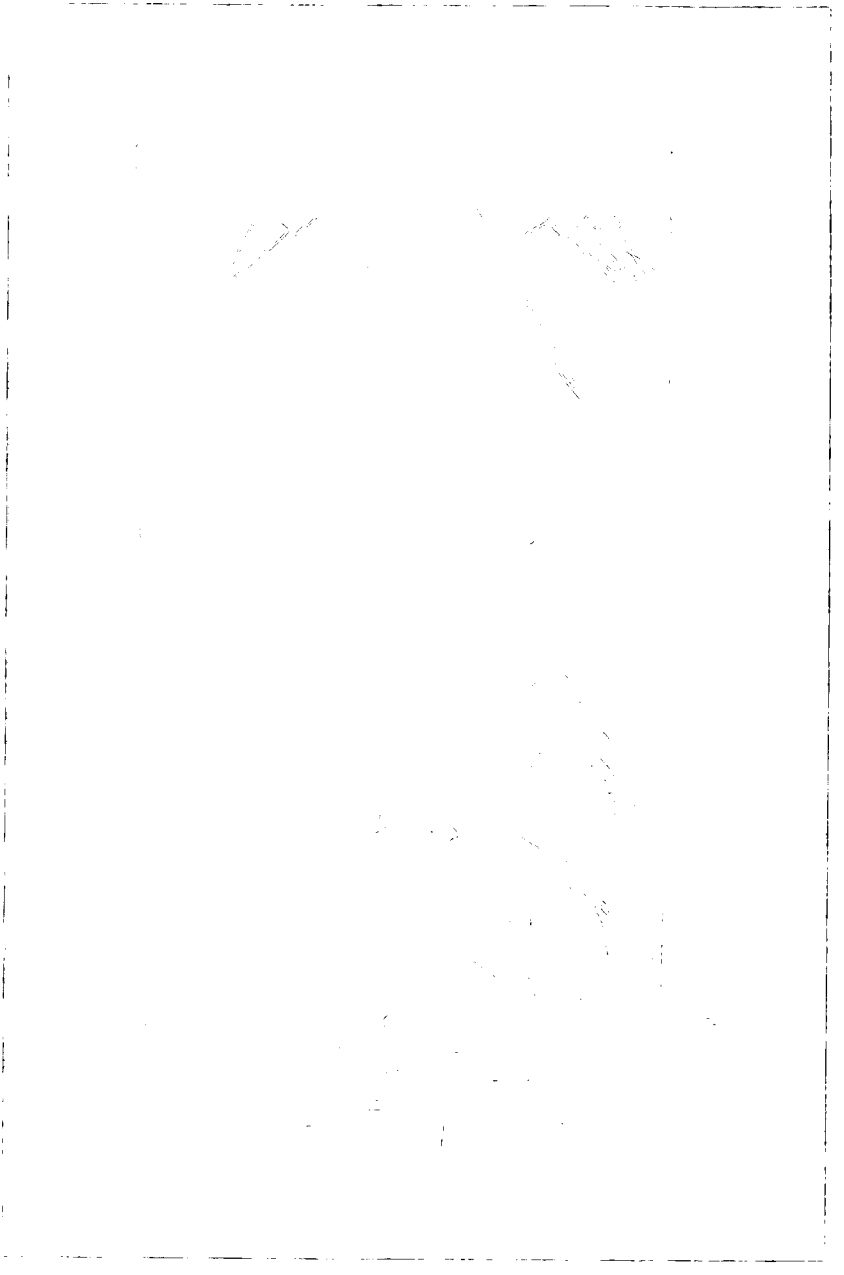

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Green, he saw, and not hazel. They didn't look at all like the suspicious ferret eyes he had seen earlier. "My wife, Barbara," he explained, pointing to the photo. "She was—she was killed today in an automobile accident."

There. He had said it out loud. Now it was true. All of a sudden, he couldn't look at the photograph. The bag lady looked from the portrait to him and back to the portrait. Then she stroked Barbara's face gently. She nodded her head up and down in a slow cadence and made a low keening sound. Henry dropped into his chair, crushing the dresses he had laid there. He covered his face with his hands and time went by.

When he looked up again, he saw that the woman had gone to the mirror by the bookshelves and was staring at her own face. She was holding the photograph in her right hand so she could see both herself and Barbara side-by-side. With her left, she held the front of the housecoat gathered together.

"Yes, you do look a little like her," Henry said. "Not much, but that's what made me stop there on the street. I—" He suddenly realized he had as much as said he wouldn't have stopped otherwise.

But the bag lady seemed not to have noticed, or, if noticed, not to have cared. "I'm Sadie," she said and Henry jerked his head in surprise at hearing her speak. "Sadie the Lady. That's me." She said it in a kind of sing-song voice. She returned her attention to the study of herself and the photograph.

Henry stood up and walked behind her so he could see the two faces from the same angle. "Yes. You know, if you did your hair up the same way, you would look even more like her." Barbry had always worn her hair piled up.

Sadie the Lady smiled, showing an incisor missing on the upper right. She put the photograph down and reached with both her hands to gather her hair into a rough approximation of Barbara's. She primped for the mirror, turning this way and that. Henry, watching her reflection, blushed. He should have known she would need new underwear, too.

The tableau in the cemetary seemed unreal. As if he were watching it from far away. Voices buzzed. Puppet figures stood about. He felt things only as if through layers of cotton. People he knew kept coming up to him and gripping his arm and telling him how sorry they were. He couldn't understand why they were so sorry, but he smiled and said everything was going to be all right.

Bill Canazetti, his lab partner, told him it was all right to cry. That he shouldn't hold it in. But Henry just shook his head. Later he would do that for Her. Just now, he couldn't.

There was a preacher. Barbara had been a church-goer, High Church, and Henry had sometimes gone with Her. He wished now he had gone more often. It was a portion of Her life that he could no longer share.

The preacher (Priest, he supposed. There was a difference.) The priest spoke of comforting impossibilities. Eternal life. The immortal soul. Barbara had gone to a better world. She had left behind this vale of tears. Henry listened. He wanted to believe it. He tried to believe it. It was better to believe such

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things than to believe that there was no Barbara at all, anywhere. Death was the Great Proselytizer.

"Most of all," the man in the funny collar said to the assembled group, "Barbara lives on in the hearts and minds of those of us who knew and loved her. We carry some piece of her with us always. . . ."

Now, that was certainly true. At least, since he had donated Her organs. There was no doubt several people already carried a piece of Her with them. And there was the DNA sample at the lab. Under proper conditions it should last nearly forever. Immortality of a sort, though he doubted that that was what the priest had meant.

Henry decided that, if Barbry did live somehow in his memories, the first thing he should do when he got home was to record those memories on tape. Everything about Her. That way he could never forget.

He had kept Her clothes and other things. He couldn't bear to part with them just yet. They were memories, too, in a way; and he wasn't quite ready to cast them out. In fact (and it would shame him if it ever got out), he slept at night with one of Her slips tucked beneath his pillow.

And then there was Sadie the Lady.

Henry had talked her into staying. He didn't know why. He had put her up in the guest bedroom and let her wear Barbara's old things. Suspicious at first, she had gradually loosened up. She spoke now, at least once or twice a day; and had wandered off to her closet nest only once. She was still hoarding food, Henry discovered, in several caches around the house, which Henry left undisturbed. It seemed . . . right that she should be in the house.

The worst part had been the heroin withdrawal. Henry hadn't believed that such agony was possible. Sadie had moaned and sweated and begged him to find her connection. But her connection was in Manhattan and Henry had not allowed her out of the house, despite her pleading, her tears, and her threats. At times, he had to restrain her, physically; and found that, for her condition, she was surprisingly strong. Together, they had finally weathered the crisis; and when it was over they were both drained.

Afterwards she had begun to show more interest in herself. She bathed more regularly, and brushed and combed her hair. She became a kind of housekeeper, doing odd chores around the house. Cleaning. Cooking his meals. Sometimes mumbling to herself. Once or twice saying a few words out loud. Perhaps it was gratitude. Her way of repaying him for what he had done for her that night on the streets. Or perhaps she was trying to help him through his bereavement. Henry didn't know.

Sometimes when he saw Sadie in the hall or in the kitchen, Henry squinted his eyes and pretended to himself that she was actually Barbara. The mental novocaine was wearing off and Henry was starting to feel the pain of Barbara's loss. His little game with Sadie helped numb the pain, at least for a little while. It was a harmless bit of self-deception.

And it was only a game, of course. He knew when he did it that he was only pretending.

* * *

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It was two weeks before he returned to work.

No one else was in the lab yet. Henry had come to work early on purpose. His cubicle was at the far end of the common room, farthest from the door, and he hadn't wanted to face the others, to run the gauntlet of their pity. Not right away. He had wanted some time alone, with Barbara, in the cell library.

She really was there, in a way. The culture dish contained all the information that was Barbara. Everything, that is, except the experiences and memories that had made Her a *person* rather than an organism. He told Her how much he missed Her, but mostly he was just silent, remembering things. Then he noticed the time and slipped hastily out of the cell library before anyone could see him there. People wouldn't understand and might think him a little odd.

He returned to his cubicle and looked around vaguely, as if he were in a strange country. He fiddled with the clutter on his desk and wondered how far Bill had gotten on their project. Bill hadn't been idle, he was sure. The guy was a certified workaholic. The two of them worked well together. The tortoise and the hare. Bill was a great one for leaping ahead in flashes of intuition; while Henry was the plodder who filled in the details and proved whether Bill's gut feeling was something more than what he had eaten for breakfast.

Well, he couldn't sit here all day looking like a zombie. Lord knows what the others would read into that. He activated the terminal screen and began studying the logbook. Minutes went by.

"Henry!"

He turned and saw his partner, Bill Canazetti shrugging out of his jacket. Was it 0800 already? Canazetti laid a hand on Henry's shoulders, a heavy hand that was supposed to be reassuring. "I was so sorry to hear about Barbara," he murmured. "We all were. She was the best."

Henry took a deep breath. He had been dreading this ritual all morning. Everyone would feel obligated to say something to him. Something to remind him of what he only wanted to forget. The fact that most of them had already done so at the funeral wouldn't stop them. Perhaps it satisfied some inner need; a need to participate in another's grief. Certainly, it did nothing for Henry except pick at the psychic scab. But he could face their awful sympathy now. He really could.

"Never mind that," he told Canazetti, more gruffly than he had intended. Bill looked hurt, so he added, "it's over with. And besides, Barbry's not really gone. She's still with me. Now it's time to get on with life."

"Yes, I suppose." Canazetti looked uncomfortable. "Is there—well, anything I can get you?" He was like all the others: eager to help where no help was possible.

"A cup of decaf would be nice," Henry told him. "I do need to catch up on our project. Let me just read the notes here and then you can fill me in on the details."

Canazetti nodded slowly. "All right." He left and Henry immersed himself in the notes on the Barnsleyformer.

He and Bill had been working to improve SingerLabs' line of cell repair nanomachines. To achieve the elusive goal of Whole-Body Repair.

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C/R nannies had changed the face of medicine over the last ten years, ever since Singer had created the first one. Repairing damage to tissues was easy now. All the doctor had to do was inject a dose of microscopic machines into the affected tissue. The nannies would visit each cell; compare it to the blueprints stored in the nucleus; disassemble any proteins not to spec; and reassemble them properly.

The problem was that, if multiple trauma was involved, only one tissue at a time could be treated. Each nanny was designed specifically for a certain tissue; and, if two nannies were introduced into the body at the same time, each would perceive the other as a foreign body and engage in a war of mutual extermination.

The information load was the limiting factor. The nannies were controlled by microscopic processors, dubbed Big NIM, that compared DNA strands in triplicate and directed the myriads of C/R machines. But even a single tissue complex involved an incredible amount of data. As Carl Sagan might have put it: Billions and Billions of Bits. There were hundreds of different proteins: enzymes and hormones. There were mitochondria, granules, and countless other cellular structures; each with a detailed set of "drawings" that described what it should look like. The limit seemed to be one tissue per nanny. Whole Body Repair seemed out of reach. There was just too much data to store and process. Big NIM always ran out of memory, no matter how much they stretched its capacity.

Bill and he had been ready to quit at one point. They had gone to see Old Lady Peeler to tell her it was impossible. There was a natural barrier, they had said, like the speed of light. Information bits must be carried on matter-energy "markers," and that set a lower limit on the scale for information processors. The machine could not be smaller than its information content. So, there was no way nano-scale processors could ever handle the data load for an entire organism, at least for an organism at the human level of complexity.

Dr. Peeler had listened to them in silence. Then she stared thoughtfully into the distance, working her lips. Finally, she had shaken her head and muttered, as if to herself, "I wonder how genes manage to do it."

And of course she was right.

Genes were natural nanomachines; yet they managed to build an entire complex organism from a single, undifferentiated cell. Morphogenesis, the biologists called it. The "unfolding" of structure from simplicity. Somehow, a zygote managed to contain all the information needed to grow a complete adult.

And that was a paradox.

Because the genes really weren't big enough to handle the information load. There just wasn't room for a complete set of elaborate blueprints in such a small space. Yet there had to be. Finally, in frustration, Henry had blurted out, "Maybe there aren't any blueprints at all!"

And that had reminded Bill of something. A dimly recalled oddity of the early 1980s. Michael Barnsley, an early chaotist, had discovered that random inputs to certain recursion formulas always generated the same precise shape.

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Take a simple random process, like tossing a coin, and define a positioning rule for each outcome. If the coin lands "heads," move a specified distance and direction from the current position. If "tails," a different distance and direction. Then start somewhere—anywhere!—on a grid and flip a coin. After the first fifty moves or so, start marking the positions where your random process takes you. Eventually, the recorded points will accumulate into a definite shape—the "limit shape." Iterate the process thousands of times. The limit shape is always the same, regardless of the actual sequence of coin tosses.

Somehow, the end result was encoded in the formula itself, irrespective of the input. It was like a magical machine that always produced the same product, no matter what raw material it was fed.

One set of Barnsley's recursion formulas generated a drawing of a fern leaf. The same leaf appeared every time he ran the simulation, regardless of the particular random inputs. That led him to suggest that the genes contained information, not on how the leaf was shaped, but on how to run the recursion formulas. With that information in hand, random chance took care of all the rest.

Many biologists, and even some other chaos scientists, had objected. There is no room for randomness in biology, they had argued. In biology, randomness is death.

Which was true, but they had missed the point. Randomness was built into the universe. The physicists had shown long ago that randomness underlay all phenomena. It impinged constantly upon biological growth and evolution. Yet, individuals within a species always matured into the same basic shape. Sometimes, two people, unrelated to each other, even wore the same face. And species living in similar ecological niches evolved into similar forms. There had been sabre-tooth cats in Pleistocene North America. There had been sabre-tooth marsupial "cats" in Pleistocene South America. Everywhere the same shapes asserted themselves. The stems of a flower species always branched precisely so. Every flower.

Once again, science had shown that there were always simple answers to complex questions. Barnsley's algorithm was a transformer. Like an electrical transformer, it changed one thing into another. In this case, it transformed random causes into deterministic results. Bill had dubbed the mechanism a Barnsleyformer, but Henry had his own private name.

He called it the Template of God.

Thus far, their work on that fatal Thursday, two weeks ago, Bill and he had learned how recursion formulas generated structure; but they had been stuck on the inverse process. Generating the structure from the formulas was one thing. Deducing the recursion formulas from the structure was more difficult. Now Henry saw that Canazetti had found a promising solution and he followed the reasoning closely in the log. Bill had decided that the recursion formulas worked the way they did because certain features of the generated structures were "fractal." That is, they were invariant under changes of magnitude. He had developed a technique he called "tyling," in which the structure was

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tyled with smaller and smaller replicates of itself. In this way he was able to create inductively the generating equations.

"The trick," he said in Henry's ear, "was getting the number of dimensions right."

Canazetti's unexpected voice made him jerk and he looked around over his shoulder.

"Sorry," said Canazetti, handing him his coffee.

Henery frowned and sipped the brew. He grimaced and looked at the cup. It was as bad as he remembered. He set it aside. "Dimensions," he prompted.

"Right." Canazetti pulled out his desk chair and rolled it under his backside. "A coin toss gives you a Barnsleyformer with up to two dimensions, a plane. But how many do we actually need?"

"Three," Henry replied. But he suspected he was wrong. Otherwise, why would Bill have asked him?

"Wrong." Canazetti shook his head emphatically. "And, once again, the physicists have been there ahead of us. Damned mechanics. Every time a bioscientist rolls over a new rock, he finds a physicist underneath it. No, Henry, there are actually eleven dimensions." Henry looked skeptical, and Canazetti shrugged. "Take my word for it." He held up his fingers. "Three gross spatial dimensions," he said, counting them off. "Length, height, and breadth. Seven quantum hypo-dimensions rolled up in what they call subspace. And . . ." He had run out of fingers and he looked blankly at his hands for a moment before shrugging. "And time. I've logged the references in there." He pointed at the disc drive.

Henry decided he would review the literature later. It sounded bizarre to him, but then, most of modern physics did. "Then Barnsleyformers must generate biological structure in all eleven dimensions," he murmured. "Son of a bitch. The morphogenesis must be incredibly more complex than we thought. No wonder our three dimensional models— Hey, wait a minute!" His head shot up.

"What?"

"*All* the dimensions? Including time? That can't be."

"Oh? Why not?"

"Because the time dimension of an organism is its lifespan. How can the gene know ahead of time how long the organism will live?"

Canazetti shrugged again. "I don't know. It's a hunch. Did you ever read Heinlein's story, *Lifeline*? But I suspect that the time dimension of the structure only specifies endogenous death. You know, from internal causes, like old age or birth defects. Exogenous death comes from outside the organism. Accidents, like being hit with a virus or an automo—" He cut off abruptly and looked embarrassed. "Sorry."

Henry was more upset by Canazetti's circumspection than by any reference to Barbara's death; but he kept his silence. What did happen to the morphogenetic pattern when death came from the outside? Eleven dimensions. Might not some part of the pattern survive the truncation, at least for a while longer. At least until the original time span was reached? The Egyptians had believed something of the sort. That the spirit

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lived on—but only for a while— somewhere beyond our normal senses. There were, after all, those seven other dimensions Canazetti had mentioned. Subspace. Might the "soul" live there?

A thought began to form in the back of his head. Something nebulous and disturbing, that made his chest tremble inside. He ignored it. "Have you begun *in vivo* experimentation?" he asked.

"Just last week. I reprogrammed a scyphozoan cell-repair machine with recursion formulas tyled from its own DNA."

"A jellyfish?"

Canazetti waved his hand the way only an Italian could. "I wanted something simple enough for a first try, but complex enough to be interesting."

"And?"

Canazetti reached past Henry and pressed a few buttons on the computer terminal. A damaged molecular chain appeared on the screen. A phosphorus group was missing entirely and several carbon rings were broken. "These are the scans recorded through the digital microscope," he told him. "Watch."

Something crawled across the molecules. It looked to Henry like a slime mold; or like tarnish growing at high speed across a set of copper Tinker-Toys. The colloidal agar for the cell repair nano-machines. After a few moments, it faded and the molecules underneath reappeared. Henry whistled.

"Like brand new," he said. "And fast."

Fast. What if it had been available two weeks ago? Would it have been fast enough? Henry refused to let himself think about that.

"Yeah." Canazetti's voice was less than ecstatic and Henry looked a question at him. Canazetti waved his hand in frustrated loops. "There're still a couple of stumbling blocks," he admitted. "For one thing, if you program the nanny with the DNA of one jellyfish, it doesn't work so well on other jellyfish."

"How so?"

"Well, every jellyfish carries the basic 'I-am-a-jellyfish' information, but it also carries information that individualizes it: 'I-am-Joe, the-jellyfish.' So, if you use it on a different individual, the nanny tries to restructure it as well as repair it."

Canazetti called up another visual on the terminal. "The jellyfish on the left," he said, "was repaired with nannies grown from the DNA of the one on the right."

Henry inspected the two cell diagrams. "How close is the match?"

"Eighty-seven percent."

"Nearly complete." Henry's own voice sounded far away. He could hear the rush of his blood in his ears. He felt light-headed. Nearly complete.

"Only if the donor and recipient are the same species," said Canazetti's voice. "Otherwise it doesn't work at all. Rejection sets in. Even within a species, I suppose the greater the initial similarity, the better it would work. That's just a hunch. But it doesn't help the doctors any. We want to repair cells, not rearrange them."

Henry tapped the screen with a fingernail. "Then why not clone the nannies from the patient's own cells; tailor them individually for each patient?

"That would be fine, except for stumbling block number two. It takes

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time to style the material and to deduce the recursion equations. Remember, there are eleven dimensions to consider. And then it takes more time to grow the nannies. What's the patient doing in the meantime?"

Dying, obviously.

We could have saved her, if only—

If only—

If only—

Henry felt faint. He sagged in his chair and Canazetti's hairy Italian arms reached out and braced him.

"Easy there. Are you all right?"

"Yes," Henry told him after a moment. He rubbed his face with his hand. "Yes, I'm all right."

"Easy there. Are you all right?"

"Yes," Sadie told him after a moment. She rubbed her face with her hand. "Yes, I'm all right."

It was Friday evening and he was seated at the kitchen table, eating the late supper that Sadie had prepared for him. Setting the pot back on the stove, she had staggered and slumped, almost spilling the pot. Henry wiped his lips with his napkin and pushed himself from the table. He went to Sadie and took her by the arm. He felt her forehead.

"You look flushed. Why don't you go upstairs and lie down. I'll bring you some medicine."

"No. 'M a burden, me. Too good to ol' Sadie. Time t' move on."

"Nonsense. You go upstairs. You've been working too hard these last two months. Maybe you've picked up a flu bug, or something."

He watched her leave and waited for her footsteps to die away. Then he went to his briefcase on the table in the hallway and opened it.

The zip-locked baggie lay on top of everything else. He picked it up and held it. There were three gelatin capsules inside. One was a specific against the flu bug that he had given Sadie. The other two— He began to open the bag but found tht his hands were shaking too badly to break the seal. He set it down and leaned with both his hands on the table. He closed his eyes and breathed several long slow breaths.

". . . the nanny tries to restructure as well as repair."

She's only a bag lady, after all, and an addict. It's for her own good.

"I suppose the greater the initial similarity, the better it would work. . . ."

She'll just find her way back to the streets again. I can't baby-sit her forever. She'll find her connection again. An addict's need never really dies.

". . . the time variable only specifies endogenous death. . . . Exogenous death comes from outside the organism . . . there are eleven dimensions to consider."

And what kind of life was it, living from a shopping bag on a heating grate? She'll be much happier.

When he felt calmer, he picked the bag up and pulled it open. He poured the three capsules into his hand. He looked at them and rolled them back and forth in his palm. They felt cold and heavy, like stones; but he knew that was only his imagination.

Before he could think about it, he turned and climbed the stairs, two at a time. He stopped in the washroom and filled a glass of water and took it with him to the guest room.

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Sadie the Lady was lying in the bed. She hadn't bothered to take her clothes off. She seldom did. Henry still had to remind her to bathe about once a week. She was propped up on the pillows, but her eyes were closed and her breathing was shallow.

"Sadie?" he asked. She had to be conscious to swallow pills.

The bag lady opened her eyes and mumbled something incoherent.

"It's only an autumn cold," he told her. "Here. Take these." He thrust his hand out. The capsules seemed to have grown warmer. They were like small coals in his palm. "Take them," he said again. And his voice trembled.

Sadie reached out her arm and Henry saw the tracks of the needlemarks lining the inside. Small red circles. Craters left from years of meteoric bombardment. "Here. Take these pills." And the words came more easily this time; and the capsules had ceased to burn his skin.

She plucked them from his outstretched hand and placed them one at a time in her mouth, following each one with a swallow of water. Her throat worked and they went down. She gave him back the glass. "T'anks."

The glass rattled when he set it on the end table. He waited. The minutes dragged out. Sadie's breath came more and more slowly, until finally a light snore told Henry that she was asleep.

For a few minutes he stood there, clenching and unclenching his hands. Finally, he nerved himself and reached down and lifted her in his arms. He was surprised to discover how light she was.

He carried her to the master bedroom and laid her down on Barbara's side of the bed. He pulled off her shoes, and adjusted the sheets around her. Then he went to the stereo in the wall unit and fumbled a cassette into the tape deck. He hit play.

The voice that issued from the speakers was his own. He turned the volume down low, so the words were barely audible. The speakers whispered. Memories of Barbara. Her family; her history; how they had met; her life with him. Henry listened for a few minutes, but after a while he couldn't take any more, so he tip-toed out of the bedroom and eased the door shut. Behind him, memories played into sleeping ears.

The next morning, he began calling her "Barbry."

The first couple times earned him curious glances, but the bag lady seemed just to shrug it off. She seemed to accept everything he did with an odd mixture of blank fatalism and a pathetic eagerness to please. Henry dug out the old photo albums and spent all day Saturday showing the pictures to her. This is Barbry when She was six. This is the house She grew up in; and those are Her parents. Sadie nodded and grinned her gap-tooth grin. Once, passing a photograph back and forth, their hands touched and Henry was caught between a sudden desire to clasp her hand and an equally sudden desire to pull away.

She studied the pictures carefully, holding them close to her eyes, squinting, as if something had gone wrong with her vision. As if her eyes were not what they had been the previous night.

Henry peered at her face. Did it already look a little different? Were the cheekbones a little higher? The hair a little lighter? The scar a little fainter?

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Or his imagination a little wilder?

A human body was more complex than a jellyfish's; and the process should take a good deal longer. But Bill Canazetti's tyling algorithm was wonderfully simple; and growing a Barnsleyformer from Barbara's DNA had taken more time than brilliance. For three weeks, Henry had remained at work, after the others had gone for the day. Bill had given him some quizzical stares over the extra hours but seemed to assume that Henry was using the work as a way of dealing with his grief.

And, in a way, of course, he was right.

Henry thought he had covered his tracks pretty thoroughly. The recorded weights of the specimens in the cell library would still tally. All the reagents and other supplies were properly accounted for. There was nothing out of place that they could trace to him. Not even the flu virus. Certainly not Barbara's cell samples.

"You must have loved her very much."

He emerged, startled, from his reverie. Sadie the Lady was holding out a snapshot. It was a picture of him and Barbara, taken during their vacation in the Rockies. There they stood, his arm around Her waist; both of them smiling foolishly, waving to the stranger who had held their camera. They were posing in front of their rented Bronco on the old railroad trestle on the Corona Pass Road. Behind them, the Devil's Slide fell a thousand feet into the forest below. Barbry was pointing back toward the Needle's Eye Tunnel that they had just negotiated. A frozen moment of happiness.

Henry remembered every detail of that day. The bite of the insects. The sawtooth sound of their chirping. How the sun had beat down on them, and how, despite that, it had been chillingly cold at the summit. Corona Pass was not a real road, but the remains of a narrow-gage railroad bed that switchbacked up the sheer side of a mountain. It was one lane wide, which made for interesting decisions when upslope and downslope traffic met. The Needle's Eye, a hole pierced through solid rock, had once been closed for several years by a rockslide, and the trestle over the Devil's Slide did not inspire great confidence, despite its solid timbers. The ruins of the old train depot lay astride the Continental Divide, and Barbry and he had found a secluded spot off the nature trail there, and had necked up a storm as if they had been teenagers.

"Yes. Very much," he said. "I miss her." More than anything else in the world, he wanted her back. "I love you very much, Barbry." And he looked Sadie straight in the eye when he said that.

Fear danced in her eyes, and then something else. "I lo—"

The snapshot flicked from her fingers and floated like an autumn leaf to the carpet. Sadie's left cheek twitched and she stood and trembled like a fawn. "Don't feel good," she said.

Henry caught her before she fell and carried her back to the bedroom. "You're still sick, Barbry," he told her. *(Yes, her hair was definitely lighter now.)* He laid her down on the bed. "Rest up. Everything will be all right in a little while. A couple of days, at the most."

The cheek was twitching constantly

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now. It tugged at the nose and the corners of the mouth and eyes. Henry could swear he saw the cheekbone beneath it *flow*. He pulled a chair up next to the bed and sat there rubbing first one hand then the other.

Sadie began to pant, short gasps, bitten off. Her eyes bulged and sweat rolled off her forehead staining the pillowcase. She arched her back and her eyes rolled up in her head. Her hands clenched into fists that twisted and wrung the sheets. A scream trickled through her tightened throat.

Henry saw a tremendous spasm run through her right thigh muscle. It jerked once, twice, three times. Then Sadie collapsed. Her mouth hanging slack and her fingers curling and uncurling. Her breathing became long and shallow, as if she had just finished a long race.

Henry could not move. *The nanny will try to restructure as well as repair*. But, dear Lord, he had never imagined that it would *hurt*. How long will this go on, he wondered? He bit into his knuckles and drew blood.

Her breathing began to quicken again, rasping like a saw through pine, and Henry saw the tension build in her muscles. It was like childbirth, almost. Worse than childbirth. She began moaning and the moaning increased in pitch and tempo and would have ended in a scream except her jaw was so tightly clamped that nothing but a whine escaped. Her whole body jerked this time and she rolled halfway onto her side.

I can't take this, Henry thought and he pushed himself from the chair to go.

But her eyes snapped open and pinned him there, like a butterfly to a board. She spoke; and the timbre of the voice was more than Sadie, but not quite Barbara, and there was pain and hurt in it. "What are you doing to me?" she cried. And she spoke again; and again there was pain and hurt, but of a different kind. "*Why* are you doing this to me?"

The scream, when it finally came, was Henry's.

For the next three days, Henry avoided the room except to bring meals, which she did not touch; and pain-killer, which she did; and to reset and play the tapes that he had made. Through the door, he would hear cries; cries that were weeping as often as they were screaming. They were muffled and Henry knew that that was because she would thrust her face into the pillows to stifle the sound of it.

Barbara had been like that. She hated to cry and always tried to hide it.

He did not linger when he heard the crying, but fled instead to the quiet of the kitchen and, once, to the solitude of the greenbelt behind the house.

He got no sleep that weekend and when Monday came, he called in sick. Bill Canazetti took the call and Henry wanted to tell him that Barbry wasn't feeling well so he was staying home to take care of her. But he said nothing, because Bill might not have understood.

Or perhaps, he might have understood too well.

Late Monday afternoon a hammering sound brought him running up the stairs. He burst into the room and found Barbara/Sadie banging her head against the headboard of the bed. She would lean forward and then throw her head back hard against the carved wood. There were dark stains there.

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His heart dropped like a stone. He bounded to her side and wrapped his arms around her to hold her back. "What are you doing?" he cried.

She grabbed her head in both her hands. "Make it stop!" she sobbed. "It hurts so much! Please make it stop!"

The brain, he thought. The nannies have reached the brain and are restructuring it to look more like Barbara's brain. Synapses and neurons were being rewired. Network configuration was changing. *It shouldn't hurt*, he told himself. *It wasn't supposed to hurt*. He held on to her more tightly and she buried her face in his shoulder, making small, animal sounds.

And what will happen now? Wasn't memory stored in the arrangement of synapses? In the network? No one really knew. No one understood how the brain worked. And there were always those seven "ghost" dimensions in Barbara's DNA.

He tried giving her headache medicine; but that didn't seem to work; so he tried a sedative and that at least stopped the whimpering, although in her sleep she continued to moan and toss.

And then, after a very long while, it was Tuesday. . . .

He was in the kitchen, drinking breakfast. Bourbon, neat. An anaesthetic to dull his own pain. He had not showered nor changed his clothes since Friday and they were stained at the collar, at the armpits, at the small of the back, in the crotch; and smelled of sweat and fear. Four days of stubble had made sandpaper of his face. His eyes were rimmed with red. He had not slept since Sunday.

A footstep in the hall.

He jerked his head up. She stood there, unsteady, leaning against the doorpost from the hallway, her jeans and blouse as filthy and disarrayed as his. More so, since she had been unable to visit the bathroom during her ordeal. Her hair, dirty from sweat and oil, was ratted and tangled. It was as if she had never left the heating grate in Hell's Kitchen.

He put his shot glass down so hard that the amber liquid splashed onto his hand. He half-rose from his chair. "Barbara?"

She stared at him vacantly. After a few moments, she shook her head. "No, I—Henry?"

He stood and walked around the table to her. "You've had a bad accident," he told her. "Amnesia."

As he got closer to her he began to see more clearly that she was not quite Barbara. The facial scar was gone; but a faint line remained. The missing incisor was still missing. There were other, more subtle differences; but differences that thirteen years of marriage had made plain.

He took her hands in his but stopped short of embracing her.

"How do you feel."

"Bad as you look," she replied. "I—" A pause. A grimace. "Twinges, time to time." Her face tightened and she looked at him hard. "Y'gimme somethin', dincha? Some kinda pill."

"It was medicine. You were sick."

"I never been sick."

Henry swallowed. "Yes, you were. Five years ago. We took you to St. Barnabas. Don't you remember?"

She pulled her hands away. "Don't!

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Yer crazy, you." She turned, took one step, and stopped. Three heartbeats went by; then she looked back over her right shoulder. "Bright pastels," she said. "The room was painted in bright pastels. The TV set was broken and you made them replace it."

"Yes."

"No!" She put her hands to her head. "Never happened. I'se in Rochester, me. Five years 'go I'se'n Rochester!" Her hands dropped slowly. "I think I was. I—" She began to cry. " 'M confused. So confused. Henry? Help me."

He led her back upstairs to the shower and gave her Barbry's favorite baby doll pajamas. While she washed up, he stripped the bedsheets and replaced them with fresh linens. He took the soiled sheets to the laundry in the basement, but he remembered in time not to start the load while the shower was running.

While he waited for the water to stop he gradually became aware of his own condition. He rubbed a hand over the stubble on his jaw and caught a good whiff of his own odor. *I need a shower, too,* he thought. *And a shave.*

The shower felt good, and it relaxed him to the point where his lost sleep caught up with him. He decided to take a nap, so he wrapped himself in a towel and went to the master bedroom to find a pair of pajamas.

And Sadie was in the bed, asleep.

Henry stopped short and wondered why that should surprise him. After all, he had been putting her there himself. But, this was the first time she had done so on her own. She had finished showering and then come to this bed, as if it were the most natural thing in the world.

His mouth twitched and he tiptoed to his dresser, where he reached around the bottom drawer for a pair of pajamas. Her breathing behind him was soft and regular. Relaxed, even; although a slight nasal blockage made a clicking sound whenever she breathed in.

He straightened and turned and looked at her. She was lying atop the sheets, her back to him. The rust-colored camisole top had ridden up to reveal her matching panties and a small, dark mole on the lower right side of her back.

He stared at the mole for a long time. He knew that mole. Even in the dark, he could have pointed to its exact location. It was not possible for two people to have that same mole.

He dropped the pajamas, and the towel, and crept gently into the bed. When he put his arms around her from the back, he felt her stiffen; but he stroked her gently, along the flank, and up and down the back—with a light touch, the way She always liked it—and, after a little while she relaxed and began making contented sounds in her throat.

Gradually, his hand widened its area of search. Up. Around. Here. There. Her breathing quickened and she twisted to face him. Her eyes were still closed, as if she were still asleep; but her mouth sought his and they embraced.

A quiet and desperate urgency followed, with quickly breathed assurances of love and pleasure. The baby dolls joined his towel.

"Barbry," he said. "Oh, Barbry."

And she stiffened again; but only for a moment. "Oh, Henry. I've missed you."

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* * *

In the morning, he and Barbry lay contentedly side-by-side. The remnants of some bad dream nibbled at the edges of his mind; but he could not remember what it was. Something terrible. Something too distressing to be borne. He felt like a swimmer who had been sucked under by a sinking ship; who had kicked desperately toward the shining surface above until, lungs bursting, he had broken through into the cool, pure air.

Everything was going to be all right now.

Barbry was still asleep and Henry watched her silently for a while, admiring the smoothness of her body, the peacefulness of her face, the way her breasts rose and fell. He kept thinking that there was something he was supposed to do for her. Something important that he had forgotten. Well, it would come to him.

He eased out of bed and put his housecoat on. Then he slipped out of the room to the kitchen, where he made breakfast for the two of them. He felt like he was on his honeymoon, but that was ridiculous. Barbry and he had been married for donkey's years. He put the breakfasts on a tray and carried them back to the bedroom.

Barbry was awake when he entered, just beginning to get out of bed. She saw he was bringing her breakfast and laughed. "Breakfast in bed? Oh, Henry. No one ever done that for me." She put herself back under the covers, sitting up against the pillows.

Henry knew that the accident had given her partial amnesia, so he didn't make an issue of how often they had done this in the past. He opened the legs of the tray and set it across her, then he crawled in next to her.

She explored her breakfast with her fork. "What's this?" she asked.

"Poached eggs. Just the way you like them."

"Just the way— Course. Forgot."

While they ate, Henry noticed her giving him sidelong glances out of the corners of her eyes. She was watching him. Waiting for him, to do what? Henry took a bite of his toast and chewed. When he glanced back at her, he noticed a tear had worked its way down the side of her right cheek.

"Barbry! What's wrong? Why are you crying?"

"Nothing." She shook her head. "Nothing. Someone's died, is all."

"Died?" An unaccountable shiver ran through him. "Who?"

She looked at him and he saw there were tears in both her eyes. Tiny tears. She seemed more wistfully sad than bereaved. She shook her head again. "No one you ever knew," she said. "No one you ever knew."

She was in the library, sitting in her chair, but with her legs pulled up under her. She had a book open and she was reading it intently. A frown creased her brows and her lips moved silently as she followed the words across the page. He came up behind her and leaned on the back of the chair.

"What are you reading?" he asked.

"The poems of Tennyson," she replied. "Tennyson was h—Tennyson is my favorite poet, but I don't remember any of his poems."

He rubbed her shoulders with his hands. "It was a bad accident," he told

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her. "It will take a long time to remember everything. The doctors didn't have much hope for you, you know. But we showed them, didn't we?"

She twisted and looked at him. She patted his hand. "Yes, we showed them. You'll play the tapes for me again tonight, won't you, dear?"

"Of course."

"Good. Meanwhile . . ." She turned back and reopened her book. She found her place and ran her finger down the page. "This poem. Could you explain what it means? It's called 'Tears, Idle Tears.' I'll read it to you."

She hefted the book and cleared her throat. Then she began to recite:

'Dear as remember'd kisses after death,
And sweet as those by hopeless fancy feign'd
On lips that are for others; deep as love,
Deep as first love, and wild with all regret;
O Death in Life, the days that are no more.'

He felt it rise in his throat. A feeling of intense longing and loneliness. There was no question about it. The old Brit knew how to string words together. But why should those words affect him so?

He felt the tears warm his cheeks. He tried to excuse himself to Barbry, but no words came out, only uncontrollable sobbing. It was embarrassing. He was crying like a baby. He had not cried like this since . . . since . . .

There was something that was supposed to have made him cry like this, but he had forgotten what it was. Forgotten when it was. Forgotten everything, except that he was supposed to have cried; and that now the crying may have come too late.

Bill Canazetti fidgetted nervously by the front door, waiting for . . . her to get his coat. Dinner had been uncomfortable. A mostly silent affair, broken only by the tink of glasses and silverware. Afterwards, a few awkward sallies into conversation. Then he had made his excuses to leave.

She brought his coat to him and helped him into it. "Now, be sure to button up, Bill. It's chilly outside. The leaves are all off the trees. It's a lot colder here than where we used to live. It's too bad we don't get together more often."

"It's a long trip to Morristown," he agreed. He only wanted to leave. To get away from this place. To forget everything he had seen.

When he looked at his hostess, he saw Barbara Carter, smiling, waiting. He had always kissed her when leaving their house. A quick pass across the lips and a murmured quip about her husband finding out. It was a little game they had played between themselves; but there was no way this woman would know about it. Henry's theories about the seven hidden dimensions holding a person's soul and memories were just so much nonsense. Weren't they?

He put his hand on the doorknob and twisted. The chill autumn air swirled in around him. He hesitated. He had to know.

"Barbara," he said, turning around. "Tell me one thing." He searched her eyes. "*Are* you Barbara?"

Changes chased themselves across her eyes. Surprise. Curiosity. Wonder.

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Perhaps, wistfulness. "Most of the time," she said. "More and more nowadays."

"But—"

"But am I really her?" She laughed and shook her head. "No. I'm just an old junkie bag lady, me. He gave me something. A nano—"

"Nanomachine."

"Yes, thank you. A nanomachine. It rebuilt my body. It rewired my brain. I remember Sadie, but it's faint, like an old dream. And I remember some other things. Things that happened to Barbry. They're faint, too. Did they come from the tapes? Or from somewhere else? I don't know. And there are other odd memories. Things that never happened at all, either to Barbry or Sadie."

Canazetti's throat felt tight. "Sadie's memories patched onto different circuits. They're hallucinatory, those memories."

"Maybe. Still. I know who I am. Most of the time, anyway."

"Then why do you do it? Why do you stay with him and pretend? I've done some experimental work. With frogs. The nerves. When they change. It—" He didn't know how to put it. "It must have been painful," he said, not looking at her.

"Yes. Yes, it was. Very painful. But Henry saw me through it."

He turned to her. "He might have killed you," he blurted out. "He didn't know enough to try it. We *still* don't know enough to try it. Dammit, he had no right to do what he did to you!"

"Bill, do you know what my life was like before he rescued me?"

He shook his head.

"How can I explain it? I can go to sleep and not be afraid that I'll freeze to death before morning, or that some kids will set me on fire just for the hell of it. And my new body, it's healthy. It doesn't *need* snow or crack like my old body did. And I can see and understand so much that I couldn't before, because my brain has been de-toxed."

Canazetti looked past her shoulder, down the hallway, into the kitchen where he saw Henry carrying dinner dishes to the sink. He was humming to himself.

"Do you love him, then?"

"Yes. Both of us do."

His head jerked and he looked at her.

"When I'm Barbry," she explained, "I love him for Barbry's sake. But Sadie loved him, too. Because he had saved her life. Because he took care of her. He's given her more than she ever dared to dream about. Except for one thing."

Canazetti's voice was choked. "What's that?"

"He never told Sadie that he loved her. He never saw her."

"Damn him!"

"No, don't say that."

"But, what he did to you. What he put you through. The selfishness."

"He couldn't love anyone else. He loved Her. He wasn't rational. What would you have done in his place?"

"I feel responsible, you know. It was my invention."

She put a hand on his arm. "Don't blame yourself for that, Bill. He would have tried something, even without your nano. I don't know. Brainwashing, maybe."

"I just can't help thinking that he did

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something wicked. A crime. And he should be punished."

She turned and watched Henry through the kitchen doorway while he rinsed the dishes and put them in the dishwasher. He noticed them watching him and grinned and waved.

"He is being punished," she said. "The worst punishment of all. He thinks he's happy." ■

ON GAMING

(Continued from page 93)

Island, and other important places from the film.

Key to the game is the "Cossroads," a large X-shaped roadway that crisscrosses the board. Using this roadway is crucial, as both sides seek to build up an armory of powerful magic weapons, like the Scepter of Tir Asleen.

That first view of the game was very intriguing. The next time we came by to look at the project, the artwork—rich atmospheric paintings of the important locations, the rules, and the prototype playing pieces were all done.

All that remained was to play the game, which we did with pleasure.

Even though we were using photocopies of cards and paper clips to record our characters' values (in things like prowess and magic), the feel of the game was all there. Encounter Cards, drawn each turn, provided the real action of the game. Some cards could be played immediately, while others can be held, providing a surprising turn of events.

For Evil to win, an evil player must have the Elora Danan card (the prophesied baby), and enter Nockmaar Castle . . . and hang on for one more round. The Good Players must slay Bavmorda, the evil Queen, *or* bring the baby into a "freed" Tir Asleen.

Though the game features simple rules for movement (with characters moving one or two spaces unless they have a horse or a Pegasus), there's still plenty of challenge to the game. Deciding what cards to keep or discard can be crucial, and being a good poker player might be a helpful attribute in playing *Willow*. The opportunity to learn new magic spells and acquire powerful friends can keep character's strength always changing.

Happy as he is with the game, Greg still had an answer when we asked him if there was more he would like to do with *Willow*. "I'd like to refine the game down to its essence so that the effect would be the same. I'd like to see it simpler than it is. . . . "

As for us, we are just looking forward to the game, transformed from idea to prototype to finished product. ■

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the reference library

By Tom Easton

Unicorn Mountain, Michael Bishop, Arbor House, $17.95, x + 367 pp.
The Paladin, C. J. Cherryh, Baen Books, $3.95, 416 pp.
Islands in the Net, Bruce Sterling, Arbor House, $17.95, 348 pp.
Adulthood Rites, Octavia Butler, Warner, $16.95, 272 pp.
The Breeds of Man, F. M. Busby, Bantam, $3.95, 294 pp.
Terry's Universe, Beth Meacham, ed., TOR, $16.95, 240 pp.
Robert Heinlein, Leon Stover, Twayne, $17.95, xx + 147 pp.
A Brief History of Time: From the Big Bang to Black Holes, Stephen W. Hawking, Bantam, $18.95, x + 198 pp.

It is such a general rule that people are meatheads that it is worth loud hosannahs when we discover an enclave of reasonable, sensible, accepting, tolerant folks. So we must conclude from the wealth of meathead stories in the newspapers, on TV, and in fiction, and from the scarcity of the hosannahs. The same ratio seems to hold in science fiction, but there just may be a writer or two trying to balance the scales.

One of these writers is Michael Bishop. In his last book, *The Secret Ascension,* he gave us an alternate reality, very Dickian, filled with meatheads (let's call them *carnikopfs* for a change), with a few good folks striving to exchange that reality for a somewhat kinder one. Now, with **Unicorn Mountain,** he takes a different tack. He focuses on a small enclave of reasonable people who must cope with a carnikopf context. These people can be carnikopfs too, at times, but their carnikopfischness is subject to growth and change. For those outside the enclave, there are degrees of carnikopfischness, with some who show signs of reasonableness and some whose brains are irretrievably hamburger.

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May I crack that Bishop is just Dickin' around? Like its predecessor, *Unicorn Mountain* is a very Dickian book, dedicated to the mutability of reality. It is also deeply imbued with sex. Nothing explicit ever happens, but center stage is occupied by a twinky (Bishop's word) with AIDS. His brother works for a condom maker. There are unicorns, ill themselves with a disease very like AIDS, and just in case you miss the phallic significance, Bishop has his twinky do a TV commercial for his brother's condoms starring—you guessed it—unicorns. In other words, rampant symbolism.

The tale begins when Libby Quarrels's ex-husband, Gary, approaches her in a Colorado store to say his cousin Bo has AIDS. Bo's parents have cut him off. Gary cannot take him in—What would people think? And after all, it's in the blood! He has no one. But years before, he bucked hay on the Quarrels ranch. Does Libby remember? Will she do *something?*

Of course she will. With money she cannot really spare, she flies to Atlanta to fetch Bo back to Colorado. Home again, she and her Ute hired hand, Sam Coldpony, settle him in and try to conceal the secret of the unicorns on the mountain behind the ranch house. But Bo finds out. So in due time do the local people, when a parade mounted to cheer up the dying AIDS victim is taken by Sam for a lynching bee (carnikopfischness is only to be expected, you see). He recruits the unicorns to stampede down the highway and rout the mob. He also alerts the media, though the unicorns don't seem to photograph well at all.

Meanwhile, Libby's antique TV set is showing programs that reveal another world where unicorns are succumbing to a plague. The local unicorns seem to be fleeing their home reality through 'spirit gates'; sadly, just as they begin to recover, their instincts drive them home for reinfection. Libby, Sam, and a local vet are struggling to save at least a few.

Meanwhile, Sam's long-lost wife commits suicide and begins to haunt him, trying to drive him to a rapprochement with his daughter. She, in turn, is having visions and will dance the Sun Dance come July; later, blessed with mystic *powa'a,* she will enter training as a tribal shaman.

Bo finds acceptance from Libby, from Sam, from his brother, and much to his surprise from the broader local community as well. The carnikopfs are outsiders, often by deliberate choice, as is Bo's mother. The tale is of acceptance, of the healing effect of caring, of love, and it works very well indeed.

What are the unicorns doing there? The story might have been told without them, but they are not simply an element of fantasy (unicorns, forsooth!) added to make the book more marketable. Bishop has returned to the symbolic root of the unicorn as the phallic emblem of innocence. He uses them as allegory, parable, emphatic underlining of his theme. I am sure that some will find the symbolism rather heavy-handed, but to my mind Bishop handles it deftly and effectively. He handles it so well, in fact, that I am giving this one a Nebula recommendation, and I will not be surprised to see it pick up many more on its way to the prize.

When I couldn't get more than a hundred pages into C. J. Cherryh's latest blockbuster *(Cyteen),* I wondered whether she had lost it. But *Cyteen,* as an excruciatingly detailed family saga, in which the "family" is a woman of power and her subsequent clone, is pre-

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sumably of immense interest to many readers who burn to know every little thing about life and intrigue in Cherryh's vision of future history.

Much to my relief, Cherryh soon reminded me that she always has one more string to her bow. The reminder came in the form of **The Paladin,** a book which seems much less science fiction or fantasy than a historical novel. The people, customs, history, and names all fit our sense of ancient China,[1] and Cherryh offers nothing—no wizards, spells, ancient astronauts—to betray our impression that she is talking about our own past. We suspend our disbelief in a way that differs greatly from our usual mode.

The Paladin begins on a mountain just past the border of the empire. Years before, when a weak prince and a wicked schemer conspired to kill the emperor and all those loyal to him, a paladin (a noble warrior) fled. In due time, wounded, he came to the mountain and became both a living legend and a hermit. Now comes a ragged youth, craving vengeance on those who slew family and village, to beg his teaching. The paladin refuses, as he has before with others. But then a movement reveals the youth to be a girl, and her refusal to take no for an answer reveals that she is a girl of immense obstinacy.

The paladin succumbs. He agrees to teach her. Then, as she fleshes out with better food and exercise, he begins to eye her as something other than a student. But she will not play. She insists that he teach her, or she will leave. And he cannot stand the thought of that. He has grown used to her presence, her aid. He loves her. And when she finally does leave, having learned what she is sure is enough, he goes with her.

Do they, invincibly together, defeat the Evil Empire? The answer is irrelevant, for though the subsequent campaigns occupy a sizable portion of the book, Cherryh makes her point before they begin. That point is that women, if they insist long enough and hard enough, can escape the slavery of being sex objects and helpmeets. They can establish themselves as the equals of any man. And more—their goals are as worthy of coming first as any man's, and the woman who finds true freedom will also find that her male partner, wed or not, will recognize that truth. If she is lucky, she may even find that he recognizes how parallel their interests truly are.

Why should women have to insist on their freedom? Cherryh says that men too—*people* too—must repel tyranny, that freedom is never a gift but must be earned anew by every individual and every generation. And we might reflect that women's rights are never an issue in autocratic nations, even though women may be forced there into a subservience that would horrify Americans if they could meet it face to face. There the battles are for political, religious, and economic freedom for all. When *those* battles have been won, a people can begin to fight for freedom from racism and sexism (and otherisms), to broaden their society's definition of "all."

Bruce Sterling has been lumped in with the Cyberpunk writers because his stories, like theirs, often deal with in-

1. I am no expert on oriental history, but I suspect that Cherryh had in mind the maze of small kingdoms and empires that preceded the unification of China. What supports this impression is that a neighbor of the land of the story is Shin, and Chi'in was the state that annexed its neighbors in the third century B.C. to forge the nation that became modern China.

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timate human-computer symbioses. But his vision is less narrow than theirs, and he does not believe, as they seem to, that the only reality that counts is in the streets among the wireheads, dataspace cowboys, and neuropeptide addicts. He agrees that, yes, as computer technology continues to improve, the day is inevitable when humans will accept computers into their skulls, move into the dataspaces in which the computers live, entwine organic and silicon lives as intimately as ever a cowboy and his horse or a suburban 1950s teenaged male and his hot rod.

So he's Cyber. But he's not punk. He recognizes the inevitable, and from that he constructs scenarios, optimistic, pessimistic, frightening, elating, all within the cards of possibility. He is easy to believe, and nowhere easier than in his latest book, **Islands in the Net.**

The time is early in the history of *Homo cyberneticus*. War has been banned, and the vast nuclear arsenals dismantled. The coldly inhuman corporate bureaucracies of today are being replaced by multinationals such as the Rizome Group, held together by an esprit that closely resembles the fellow-feeling that marks a large and happy extended family.[2] The Group defines itself by saying that it has people, and work that needs doing. Its people's motives are *not*—or are not supposed to be—power and wealth.

The story begins to emerge when Sterling adds to these basics that the world is growing ever more tightly linked by computerized data exchanges, summing up to the "Net" of the title, but there are a few places—islands—that parasitize the Net as data pirates (e.g., Grenada, Singapore). There is also Africa, so beset by ecological and political disaster that it is a metaphorical island totally surrounded by the Net, but not a part of it. And now we have Laura and David Webster, Rizome Associates, managers of a guest house on the Texas coast, building up points toward the day when they will ask Rizome to support them in a larger undertaking.

It looks like an unexpected point bonus when Rizome schedules a conference of data pirates at the Webster guest house. It is, if not quite in the expected way. Rizome wishes to talk the pirates into giving up their nasty ways, but then terrorists assassinate the chief Grenadan on the beach, beside Laura and her infant daughter. The pirates flee. Rizome can save face only if its representatives—David, Laura, and baby—go to Grenada as little more than diplomatic hostages. They go (expecting those points), and the reader learns a great deal about grinding poverty, an ideological allegiance to bootstraps, and promising futures.

But the terrorists strike again, destroying all the promise. Laura and her family escape again, and now she is off to Singapore, while David chickens out and stays behind. Singapore may or may not have been behind the attacks. Whatever the truth, disaster follows Laura: a second batch of data pirates bite the dust, and she is captured by the terrorists, who in due time imprison her in Africa.

Years later, she escapes, her guided tour of disaster resumes, and she finally makes it home. The reader has been dismayed by the enormity of the future's

2. Rhizome: "A swollen underground stem commonly used for reproduction and food storage. The term is also applied to the stolon [a reproductive branch] of hydroid coelenterates." (Gray's *Dictionary of the Biological Sciences*, Reinhold, 1967. Sterling clearly seems to be comparing his new corporate structure to a root network.

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problems—especially in Africa—and thrilled by Laura's continuing string of Paulinesque Perils. Now, that reader realizes, she is a figure of charisma, more knowledgeable in the ways of the Net, prepared to use it toward some unguessed future, and Sterling must be working on a sequel. He is building a future history that is fascinating in the ramifications of events he knits into the fabric, and he can expect a horde of welcoming readers. Few will be greatly put off by the unlikeliness of humanity abandoning its nuclear missiles, or of bureaucracies coming to depend on esprit instead of power.

Octavia Butler's last novel, *Dawn*, began her Xenogenesis series by introducing strange aliens, the Oankali, whose mission in the universe is to travel, meeting other species and "trading" genes with them. That is, when they find a sentient species, they add its choice traits to their own and give it their own traits in exchange. The result is a merger of species.

In *Dawn*, we learned that the Oankali came upon Earth shortly after the Big Blowup. They salvaged as many surviving humans as they could, stashed them in suspended animation, and set about helping Earth recover. With that accomplished, they awakened a few humans, told them what the deal was, and said, "Well?" Those humans who could accept the new order of things became part of five-part human-Oankali marriages and gave birth to the new, blended species. Those, the resisters, who could not accept were sterilized and turned loose on Earth.

Now, here's **Adulthood Rites.** The resisters live in childless settlements scattered in the forests of Earth, trying desperately to rebuild a barren civilization. Those humans who have mated with the Oankali live, with children galore, in villages that are actually baby spaceships; eventually, if and when the species have merged successfully, the ships will mature, devour much of the planet, and take off in search of more sentients.

The tale begins when Akin, a hybrid infant, is stolen by wandering resisters. Akin looks unusually human, lacking most visible signs of his Oankali heritage, but though he cannot yet walk, he can speak and remember. In due time, he winds up in the village of Phoenix, and there he stays. To his bewilderment, no one shows up to rescue him. He figures his people are leaving him there on purpose, perhaps to learn something of his human side. And learn he does, the best and the worst of which humans are capable. When he finally does leave, it is with the conviction that the human resisters deserve more consideration: The Oankali had the wisdom for themselves to split—only one group will merge with the humans; a second will not, so that if the first fails disastrously, the Oankali species will go on. Why, asks Akin, cannot the humans too have a reserve, a hedge against disaster?

Why not, indeed? He grows up and finds that many Oankali feel the humans have already had their disaster. They have blown it once, thanks to the basic contradiction between hierarchy and intelligence at the root of their nature, and lucked out with an Oankali miracle. They deserve nothing more, and if they received more, they would surely blow it again.

This is the attitude against which Akin must struggle as he searches for a solution to the human dilemma. He must also struggle to come to terms with the scars he carries from his kidnapping, from his absence-induced failure to bond properly with the sibling that

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should become his mate, from . . . Curiously, Butler is more successful with this aspect of her story. For all the alienness of Akin's being, so marvelously portrayed, the reader identifies with his personal problems. The larger problem, though it must surely have much to do with the future of Butler's series, resolves itself in the shadows. This may, perhaps, be how history actually works itself out, but it leaves the reader wishing for a somewhat stronger sense of direction. This may be the kind of series that cannot be read properly until the whole thing is in hand.

F. M. Busby's **The Breeds of Man** is a disappointing effort. Busby posits that the AIDS epidemic will get much worse before the Phoenix Foundation comes up with a cure that works by strengthening the immune system. Unfortunately, any woman who gets pregnant thereafter becomes immune to all sperm from men of the same blood type as the daddy. That is, faithful, monogamous women can have but one child. Since the people of Busby's world are mostly faithful and monogamous, the population immediately begins to decline.[3]

Fortunately, the Phoenix Foundation waves its managerial wand, puts a few scientists to work, and finds a cure. Unfortunately, the children born to cured parents are peculiar: they have two sets of sex organs, one normal, one initially rudimentary, and at puberty they begin to alternate sexes. That's a nifty idea, but Busby ignores most of the psychosocial ramifications. Instead, he tells us that the nation is full of paranoid, hysterical religious fanatics, rabid FBI sadists, and bigoted carnikopfs who think his Mark Two humans are freaks, works of Satan, and/or space aliens out to corrupt all we hold dear. And then he focuses on how his Mark Twos survive the attacks of society by sheer nice-guy luck and wind up manipulating the media and government, not just to win some space of their own but also to start taking over the human species.

It's a new *Slan*, intended to appeal to juveniles (of all ages) who consider themselves outcasts by assuring them that they are really better than ordinary folks. But it doesn't work, not on this level and not as a simple adventure story. The reason is that Busby's social gibes are too heavy-handed, his science is both too unrealistic and too easy, and his heroes are too passive. He is, in other words, far too simplistic.

The word is that when Terry Carr died, he left his widow, Carol, with the "devastating expenses associated with a long, terminal illness" typical for anyone (such as a free-lance writer/editor) who lacks an employee's fringe benefit of group major medical. Fortunately, Terry had a lot of friends in the community of SF writers and publishers, and that community is generously imbued with a very clannish sense of family.

As has happened before, and as will happen again, that community has rallied to the cause. Eleven writers have donated original stories to a memorial anthology, **Terry's Universe,** edited by TOR's Beth Meacham, who says, "It is dedicated by all of us to his memory, and it is my own way of saying a public thank-you to the person who taught me everything I know about being a good editor." Proceeds from the book go entirely to pay Terry's medical bills.

How about you? Should you kick a few bucks into the pot, just to help out?

3. The effect is inevitable, given the premise of fidelity. But I find that premise curiously hard to swallow. I wonder why?

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No one can stop you, and it is a good cause. But you can help yourself as well if you just buy the book: it's a good one. The contributors are writers who credit Terry with significant impact on their own careers, some because his recognition of their potential got them started. They comprise an honor roll of modern SF: Robert Silverberg, Ursula K. Le Guin, Fritz Leiber, Kate Wilhelm, Carter Scholz, Michael Swanwick, R. A. Lafferty, Kim Stanley Robinson, Roger Zelazny, Gene Wolfe, and Gregory Benford. The stories are quirky, nifty, strange, marvelous—try Le Guin's mythically allusive "Kore 87"; or Scholz's peripatetic "Transients"; or Robinson's claustrophobic "The Lunatics"; or Benford's "At the Double Solstice," an alternate working out of some of the ideas in his *Great Sky River*. Last but not least, try Terry's own "The Dance of the Changer and the Three," a uniquely effective—and poetic—vision of alien ways.

The late Robert A. Heinlein "was arguably the most influential American writer of our day, as Twain was in his. And that is why this book is written, to help explain that large fact—one that cannot be wished away by Heinlein foes." So says Leon Stover in **Robert Heinlein.** He sets Heinlein firmly in the tradition of Whitman and his "kosmic destiny" of America; Emerson and his transcendental exaltation of business that calls America "the country of the Future"; Twain and extensive, romantic culture criticism.

Here you will find no whines that Heinlein was a capitalist, sexist fascist pig. Stover is, and long has been, a fan of SF's premier pattern-maker, and it shows. He has put his finger on what seem some very real reasons for Heinlein's popularity, and his book is a welcome counterweight to some of the more negative exercises of the last few years.

The greatest criticism to which Stover is open to is that he often seems too worshipful, too willing to call the Great One as infallible as a pope. Fortunately, he also—and inadvertently—reveals Heinlein's fallibility when he quotes a conversation with Walter Cronkite: "There's just one equation that everybody knows: $E = EC^2$."

Now, I don't believe that Heinlein could possibly have blown that one. But Stover did, in the writing, or the Twayne editors and typesetters and proofreaders, and then Stover in his own proofreading. And the typo is perfect proof that Heinlein was wrong: *Everyone*—at least in the litcrit and litpub camps—does *not* know the equation behind the Bomb.

The real world can get much weirder than anything in SF or fantasy. For instance, the other night, the phone rang. When I picked it up, a woman said, "I'm calling for the Special Olympics. You know, athletics for the mentally retarded."

I said, "I thought it was for the physically handicapped, too."

"Oh," she said. "They're the same thing, you know."

When I insisted that the physically handicapped are by no means mentally retarded, she hung up on me.

If she hadn't hung up, I could have given her a beautiful example of my point, for I had just finished reading Stephen W. Hawking's **A Brief History of Time: From the Big Bang to Black Holes.**

Hawking developed amyotrophic lateral sclerosis (Lou Gehrig's disease) in his twenties. Now he is confined to a wheelchair and can talk only with the aid of a computer and speech synthesizer.

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But Hawking is one of the foremost theoretical physicists and cosmologists of our age. He has been called the greatest mind to reach Earth since Einstein. And he has written a remarkably lucid and interesting book that concludes by saying that, if we simply step from the notion of imaginary numbers to that of *imaginary time*, there just may never have been a Big Bang after all, and that a unified theory of the universe, with which human beings will be able to know the mind of God, may be just around the corner.

I am not greatly disturbed by the impression I draw from the strained jolliness of Hawking's style that he feels as if he must talk down to most people. He probably does. I am more disturbed by the way the publisher misserved Hawking in at least two places: At the end of Chapter two, two paragraphs are so misplaced that the chapter becomes downright baffling. Later, in Chapters five and six, two illustrations are interchanged, so that a pattern of dots is labeled a proton-antiproton collision and a field of diverging, curling lines is called a starfield. Again, bafflement reigns, especially over the unilluminated to whom the book is aimed.[4]

ANADEMS

St. Martin's recently sent me a copy of **The Complete Short Stories of H. G. Wells** ($19.95, 1038 pp.). I'm not sure why, for they first published it in the U.S.A. in 1971, and Ernest Benn Limited of London started the thing off in 1927. In England, it had been through 23 printings by 1987.

You really ought to get a copy. Wells is a classic, and his collection's staying power may just be contagious enough to keep *you* around a little longer. You never know. ■

4. Note added in proof. The word is that the publisher recalled all copies of the book in order to fix the problem with the illustrations. If you bought a bad one, perhaps you can exchange it.

●If you keep saying things are going to be bad, you have a chance of being a prophet.

Isaac Singer

●Every great advance in science has issued from a new audacity of imagination.

Thomas Dewey

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brass tacks

Dear Mr. Schmidt:

What a perfectly enchanting idea—let computers handle court cases ("... And Justice for All," Feb., 1988). But it will not fly, absolutely and positively!

The premise of the article suggests "... legal proceedings consist largely of analyzing data ("evidence" and "testimony") and comparing it to a large body of written law and judicial precedent to determine what should be done in a particular case." The argument is then extended to conclude that appropriate machines with the right programming, and after controlled tests, could take up the burden of the overloaded judicial system to achieve the goal of "the right to a speedy and public trial."

As I see it, in the United States's legal system the fatal flaw in the premise has to do with the extent to which legal proceedings really do consist of analyzing data and comparing it to law and precedent. The assumption that asserts gathering evidence and testimony is a process mutually practiced by each faction in a trial in pursuit of truth is fallacious. It is an adversarial exercise in which either prosecution or defense is happily willing to distort, obscure or misstate facts and data, and resort to invalid logical processes to prevail in their position. In a jury trial (and judge-only trials to a marginally lesser extent) the object of these twists and turns is for no other purpose than to cause the minds of the jury (carefully selected for bare literacy and tapioca-like thinking) to reach, if necessary, illogical conclusions so that one or the other of the adversaries can "win." Computers and programs will never be acceptable in this venue, to say nothing of the impossibility of devising algorithms which would work.

Using limited, specific examples to

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support a general case is, of itself, not logically permitted, but may I display some exhibits of convoluted illogic of the court system. Examples seem endless, but to use a couple:

* In the area of product liability, the owner of an airplane, which had many hours of reliable and unremarkable flight operation, flew the aircraft into a known region of unstable (and dangerous) flight; stalled, spun and crashed—with fatal results to himself. His wife's lawyer brought suit against the manufacturer of the airplane for negligence because an airfoil was used which let the airplane stall. The trial was argued before a jury of certifiable laymen who had never piloted an airplane in their lives, and before a judge who had no knowledge, training or education in aeronautical science or engineering. The defense prevailed by convincing the jury, guided by the judge, that the aircraft manufacturer was negligent in using an airfoil that could be stalled even though physical evidence demonstrated, and the pilot knew, the machine would fall out of the sky if operated in an unsafe region of flight. What computer program could produce this result and be accepted by humans? Well, a computer couldn't because they're so logical, but we humans like, and permit, our little quirks and jerks of mind, and claim them as our birthright.

* In criminal proceedings, there was a case recently of a man who was stopped by two policemen in a patrol car, with a civilian volunteer ride-a-long in the back seat as an observer. As events unfolded, the man, in a scuffle which ensued, took a revolver from one of the officers, shot and killed one of the policemen, wounded the other, shot and wounded the civilian who was still in the back seat of the police car and had not been involved in the scuffle, and then took the police car, running over the wounded officer as he fled; later the police car was abandoned. A trial followed (a year later) in which the man who had been stopped by the police was acquitted! The defense attorney convinced the jury the policemen had used racially derogatory remarks against the man, and unnecessary force. This argument persuaded the jury-persons the killing, the woundings, and the theft of the police car were blameless acts for which no guilt could be assigned. I wonder if a CRAY II computer could have handled this case and achieved the same results, or, if it had, would the computer judgment been accepted as "logical," and how about "just" and "fair"?

No, computers will never act in place of judges, juries and lawyers in the present adversarial judicial system. It doesn't matter what the facts are, or the law, or precedent. We humans, and our lawyers, like the way the present "roll-of-the dice" system works. Too many rice bowls would be broken and favorite bulls gored if logic and reason crept into the system. With a streamlined, logical judicial system in place of computers, speedy trials and justice would have their day. But that's not going to happen unless the current mishmash of law, precedent, and judicial process is taken apart and simplified and codified. This will not happen because there are too many judges, lawyers, court staffs, legal staffs, office builders, office decorators, Mercedes-Benz dealers, etc., living off the present system to permit things to change any time soon.

Computers doing court trials is a great thought, don't get me wrong.

TOM DAVIS

Chula Vista, CA

Dear Dr. Schmidt:

Thomas A. Easton's article "Poetry

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with Rivets," (April 1988) would be a better stimulus to a good debate if the author had his facts straight. Blank verse and free verse are different things—and neither is a mere century old. The former goes back to Shakespeare and beyond; the latter goes back at least to the King James Bible, i.e., the Psalms. And neither Shakespeare nor the Psalms mystified their original readers! Also, long poems, contrary to Easton's remark, were much more common before mass magazines—because writers before the 19th century often produced treatises and long narratives in verse. A larger fraction of the literate population may have written poetry, but a smaller and more motivated group of people achieved literacy.

The accessibility of "light" verse has little connection with its equivocal status. Light verse of the past century has often packaged minimal content in intricate traditional rhyme-schemes. Easton's productions are quite different things; he couldn't write a villanelle or a rondeau to save himself—whether or not that is worth doing! Moreover, science fiction is not a "new form of prose"; it is just a (relatively) new kind of subject matter. And if anyone still scorns science fiction, that is because its writers have passed judgment on themselves by forming a little protective enclave and avoiding comparison with "mainstream" fiction.

It is true that a few 19th-century writers cultivated deliberate obscurity, and that their 20th-century disciples sometimes achieve seemingly random nonsense. Easton has demonstrated the uncontroversial fact that a computer can be more systematically random than a human being, but poetry still involves not just crazy images, but sound and meaning. Indeed, some recent authors have met incomprehension simply because their works had unpleasant meanings. It is a tautology, not a putdown, that one requires talent to do anything well, because by "well" we usually mean "in the top few percent." Any talented poet who has something to say—with or without a computer—will leave Easton and company far behind in the dust.

JOHN S. LEW

Ossining, NY

The author replies. . . .

The targets of satire often reveal themselves by their lack of a sense of humor.

Dear Stan:

Since "Nanotechnology" (Eric Drexler & Chris Peterson, Mid-December, 1987) seems to be becoming another bandwagon-and-buzzword, I guess I get to be the curmudgeon who is out of step with the current B&B. Their approach has (at least!) a minor flaw and a major flaw.

First, "atoms as little objects with identical properties" is true, but it's *not* true (as implied) that you can hook them together in any old way. This "Tinkertoy" approach works fine in organic chem (which indeed is where Eric got his inspiration), because you can forget about thermodynamics. The bond energies are all similar, and activation energies for reaction are high with respect to kT. Nonetheless, all organic compounds (including living things) are thermodynamically unstable w.r.t. simple compounds like CO_2, H_2O, N_2, and CH_4. Certain configuration of atoms are more stable than others, and—*ceteris paribus*—atoms will try to spontaneously reconfigure until they reach the most stable configuration. Further, large assemblages of atoms can exhibit unexpected behavior; spontaneous detonation of solids is a spectacular example.

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Which leads into the major flaw: the behavior of large, interacting ensembles of particles is *not*, in general, predictable from the rules governing interaction of the individual particles. This follows formally from studies of cellular automata, extremely simple systems in which cells interact with only their nearest neighbors according to specific, deterministic rules. It turns out that not only is the behavior of the automaton not, in general, predictable; it also seems that some systems do not have an overall or "high-level" description any simpler than the automaton itself; to find out how it will behave, you just must run it! Note also that this unpredictability has nothing to do with quantum mechanical indeterminacy. The rules of a cellular automaton are completely deterministic.

This whole field of "system dynamics" subsumes some of the most intractable, and most fascinating, problems in contemporary science: "numerical experiments," to find solutions of differential equations that elude contemporary mathematical analysis. Chaotic behavior and strange attractors. AI itself. Annealing algorithms for solving linear programming problems. Phase changes, melting, boiling, cryrstallization, the means whereby large numbers of atoms spontaneously find (and "remember") a certain ordering, which in turn changes abruptly as external environmental properties (temperature, pressure, pH, eH, etc.) are changed. (This last is even more amazing when you remember that such concepts as "pressure" are statistical; they have no meaning at the atomic level!)

Thus, large systems must be described with heuristics that have little to do with the low-level behavior of their constituent particles. Consider sciences such as meteorology; you can't predict weather from the laboratory properties of water and air molecules! Or geology. Or biology.

As suggested, too, macroscopic properties are often statistical. They result from the *average* positions of huge numbers of atoms; the exact position of any particular atom is almost irrelevant. (It's amusing that the example with the properties of glass as resulting from the arrangement of its atoms is misleading. Glass is not a crystal; it *has* no long-range order. (That's what "glass" means, in chemistry, and is why people sometimes speak of glass as a liquid.) Glass is an X-ray-amorphous tangle of silicate chains branching chaotically, like a plate of forked spaghetti, with charge balance maintained by randomly interspersed atoms. Its hardness properties are statistical.)

So: because you can manipulate atoms at will does *not* mean you can build anything. Without a high-level description—i.e., a deep understanding—of the system you're attempting to build, you will get nowhere.

An analogy: all of us (at least the readers of *Analog*) know how to manipulate the "particles" of English; we can write the letters of the alphabet, form words from letters, sentences from words, etc. But how many of us can write plays like Shakespeare's? You can't compose in English, or any other language, at the "atoms" level! You're dealing with a much higher level of organization. Alternatively, consider "reverse engineering" a Shakespeare play, trying to determine what makes it tick by studying how its letters are arranged. (Hofstadter, in his books, makes these same points much more lucidly than I.)

Another analogy: consider writing (or debugging!) a computer program bit by bit. It just doesn't work; you must consider the high-level organization in-

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stead. And furthermore: suppose you have the same program written in a high-level language, Fortran, say, and compile the program with two different Fortran compilers. The bit-by-bit form of the resulting code is very different in the two cases, yet at very deep level—and at the most natural level—the program remains the same. And in any case, the program exhibits behavior independent of its low-level representation.

When Eric and Chris speak rather glibly of "disassembling" a living cell to copy it, it suggests they really do not understand the sort of system a cell is. (Indeed, this suggests inexperience with "reverse engineering" in general!) Cells are machines, to be sure, but they are a good deal more subtle than they seem to realize. Most cellular processes are statistical; they are mediated by *concentrations* of various chemicals, where again the exact position of this or that molecule is irrelevant, but the entire system interacts in subtle but multitudinous ways. Fine-tuning a cell has much more in common with "fine-tuning" an ecosystem than tweaking a carburetor!

And creating such an entity will not be like Xeroxing a Shakesperean play; it's more like creating a Shakespearean *performance*, with all the dynamism involved. Difficult, to say the least. And if you're not a talented actor yourself —i.e., if you don't already have a deep understanding of what it *is* you're copying—you're not going to succeed.

These considerations especially apply to devising self-repairing micromachines, such as protective surfaces that "heal," or whatever. You're going to have to design such a thing "top-down"—and even more than with macroscopic engineering, the prototypes are going to exhibit unsuspected quirks. I suspect that the bulk properties of even simple materials built with nanotechnology, such as ultra-pure, defectless crystals, will have unexpected (and perhaps undesirable) bulk properties. In any case, nanotechnology will not be a magic shortcut to eliminate the trial and error of engineering design.

Finally, Eric and Chris's implicit connection between "nanotechnology" and self-replication is a *non sequitur*. One can have self-reps without nanotechnology, as von Neumann showed years ago. Nanotechnology makes them more efficient, to be sure—but that's a different statement.

Nanotechnology is a "technology." It will be a useful tool. But at least in its extreme expression, it is a *reductio ad absurdum* of reductionism. The real world is just more complicated.

STEPHEN L. GILLETT, PH.D.

The authors reply. . . .

We welcome Steve Gillett's comments; the health of a field like nanotechnology depends on critics to keep nonsense in check. Much of his criticism is aimed at what he thinks we imply, rather than at what we said and believe, so we find we agree with much of it. Other points, however, need some response or clarification.

It is true that nanomechanisms (like other organic compounds) are thermodynamically unstable in air. But so are diamonds, and diamonds "are forever" nonetheless. Thermodynamically unstable compounds often have lifetimes at room temperature that exceed the age of the universe. Designs done with an eye to chemical stability (as conventionally defined) will yield long-lasting nanomachines, if one doesn't reduce them to CO_2 and H_2O by throwing them into a bonfire.

Steve's major criticisms revolve

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around the unpredictability and complexity of some systems. It is certainly true that one can find or construct systems that are utterly unpredictable, indescribable, and useless. Engineers, however, seek out that tiny fraction of possible systems that *can* be described, and that reliably do something useful. As Steve's point suggests, this means building systems that have useful high-level descriptions, often taking the form of engineering specifications.

System dynamics does indeed include "some of the most intractable, and most fascinating, problems in contemporary science." Nanotechnology, however, is not a branch of science, but of engineering. Scientists must deal with whatever nature gives them (which may be incomprehensible), but engineers can choose to work with simpler systems. Scientists study brains with wonder and puzzlement; engineers build computers, program them, and put them to work. Nanotechnology can likewise work with systems that are designed for tractability. (Regarding glasses, their well-known lack of crystalline order doesn't invalidate our point that local atomic arrangements determine bulk material properties.)

Steve's statement that the ability to arrange atoms "does *not* mean you can build anything" might mean "there are some things you cannot build with this ability." This statement is both true and important. It might, however, be read as "there is nothing you can build with this ability." This statement would be false. Steve's point here seems to be that nanotechnology will not bring us magical new abilities to design complex systems. This is quite right and should not be forgotten—as we pointed out in our article, it is a fabrication technology, limited "by our powers of design and by physical law."

In criticizing the idea of disassembling and copying a cell, Steve points out that "most cellular processes are statistical . . . mediated by *concentrations* of various chemicals . . . the exact position of this or that molecule is irrelevant. . . ." But this merely means that (say) freezing and molecular disassembly will give us *more* information than is needed to describe the cell's state (and information of a sort that is easy to discard). Understanding how the molecular parts of a cell interact is, of course, another matter, but a photocopy machine needn't understand plot and characterization to copy the text of *Macbeth*. As for performance, a machine can copy intricate software, producing a performing result without understanding a single byte of code. Getting the parts right gets the system right, whether one understands it or not.

We hope that advocates of nanotechnology will take many of Steve's criticisms to heart and moderate their views accordingly. But the limits to understanding and modeling arbitrary molecular systems, while real, will not stop us from building computers smaller than bacterial cells, or self-replicating machines, or spacecraft of diamond-fiber composite, or even (though this indeed is a challenge of a different order) someday learning to repair cells, tissues, and organs to restore and indefinitely extend active, healthy life. As *Engines of Creation* discusses, there are limits to nanotechnology, but within those limits, much is possible.

CHRIS PETERSON and ERIC DREXLER

P.S. One of us (Drexler) is teaching a course entitled "Nanotechnology and Exploratory Engineering" at Stanford University during Spring quarter, 1988—the first formal academic course on this topic.

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Dear Dr. Schmidt:

Along with reader William Barton, I thought science fiction readers represented the hard core supporters for the space program. Two years of lecturing at science fiction conventions in the Chicago area, with concurrent attempts to recruit new members for L5/NSS, taught me otherwise. There's a lot of vocal support, but that's about it.

At one convention, the Chicago Space Frontier had paper, writing utensils, stamps, addresses, and names of all our congress critters. To everyone who walked in, we provided encouragement to write and express their views. Over a hundred people tromped through the room. Ideas and discussion flew. Net result—three letters; two from the same person. The talking was easy to come by. Writing is a commitment to action—that's hard to come by.

I also think high-tech is the solution. I wrote a program for the Commodore 64 that asks people questions about the space program. If they give correct answers (I define what is correct), it asks for their name and address, and automatically generates a letter, based on their responses, to both of their senators.

Unfortunately, I've never given the program a large scale test. The small scale prototype tests showed large promise, though.

If reader Barton, or others, would like to test and use the program, I suggest he get in touch with either one of two very active NSS chapters: Milwaukee Lunar Reclamation Society or Chicago Space Frontier. At least one member of each has a working copy. I own a working copy, but it will be six months before I see it again. Being attached to a working submarine has greatly cut into my own level of activism.

Along with the April *Analog*, today's mail brought the February 22 *Time*, which answers how many Americans support space exploration as a general idea. Eighty-one percent think it is somewhat or very important for the U.S. to be the leading nation in space exploration. Only 16% think we should cut down spending on space.

HAROLD W. HAMBLET
USS Plunger (SSN-595)
FPO SF CA 96675-2311

Dear Editor:

The letter of William Barton (April 1988) bemoaned the fact that The Planetary Society was small and activity low. He went on to illustrate what 100,000 people might do with a letter writing campaign if only they could get organized.

In fact, the Society is 20% larger than 100,000 and we (both our leadership and our members) have frequently communicated just as he suggested. We have had effective campaigns on *Voyager*, *Galileo*, planetary research and data analysis, and the Search for Extraterrestrial Intelligence, on Halley's Comet, and a partially effective one on *Mars Observer*. For the *Mars Observer*, our members generated over 15,000 letters to Congress and NASA. While we failed in preventing NASA's delay of the mission, we did uncover terrific support in Congress for Mars exploration.

We're tapping that support now with our Mars Declaration. Signed by more than ten thousand already, including major leaders and notables from every walk of life and political persuasion, we are helping bring about a new sense of purpose to the U.S. role in space exploration. Interested persons may get a copy of the declaration by writing to Mars Declaration, The Planetary Society, 65 North Cataline Avenue, Pasadena, CA 91106.

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LOUIS FRIEDMAN
Executive Director
Pasadena, CA

Dear Dr. Schmidt:

Congratulations to Stephen Kraus for reconciling science with the bible. I refer to "Frame of Reference" in your May issue. His clever idea works because the biblical account of creation and Einstein's special relativity are both devoid of common sense, and both require a great deal of faith for acceptance.

Kraus's account of the twin paradox is the standard version, but represents a special case. The more general, and therefore more honest case, would have both identical twins embark on equal but opposite journeys rather than having one twin stay behind while the other travels out. Keeping all conditions the same for both frames of reference makes a better model for analyzing special relativity. If the twins pass one another at some point while traveling in opposite directions, each will see the other's clock lagging behind his own, and each twin will perceive the other as having aged less. Upon returning home, which twin will have aged less?

According to special relativity, neither frame of reference is favored by nature. No experiment can show that motion in one frame is more real than in the other. That's why it's called relativity. If one twin should show less age than the other, the theory must be false. If neither twin remains younger, the theory is exposed as a mathematical fiction. If both twins have aged slower, it must be due to non-relativistic causes because that outcome is not predicted by the theory. Remember that each twin saw the other's clock lagging behind his own.

Ironically, any experimental evidence for special relativity must either serve to falsify it or have only some incidental relation to it.

This brings me to another paradox. Modern physics has proclaimed a profound revolution in our perception of the universe based on a theory which, at best, is fundamentally flawed and supported by experimental evidence, the relevancy of which is highly questionable. By which faith is such a procedure justified?

RAYMOND GRAUDIS
Milltown, NJ

It's true that each twin sees the other the same way as long as they are in constant relative motion, *which I suppose is where the misnomer "twin paradox" came from. When their situations are* not *symmetrical—when one twin stays home while the other accelerates, goes far away, turns around, comes back, and stops to compare notes—the "paradox" has an unambiguous resolution: the twin who stayed home has really aged more. If you want to understand what relativity actually says (which seems like a good idea before setting out to criticize it!), I suggest a careful reading of* Spacetime Physics, *by Edwin F. Taylor and John Archibald Wheeler (Freeman, 1966). Among other things, it includes a detailed analysis of why the twin paradox works out the way it does.* ■

●Beware of the man of one book.

St. Thomas Aquinas

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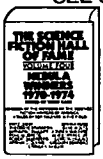

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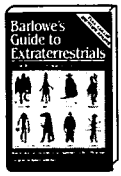

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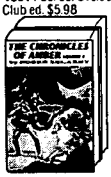

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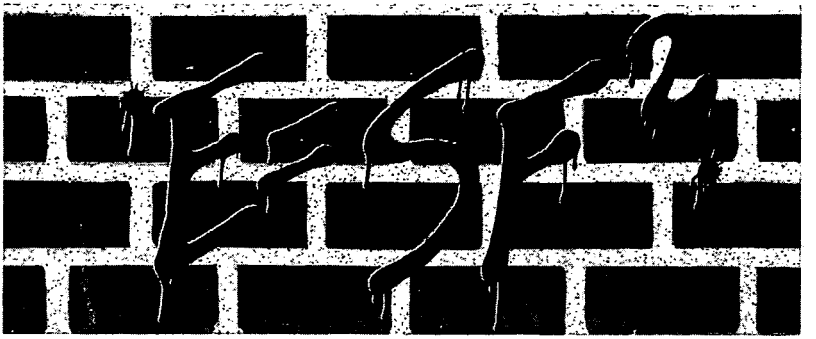

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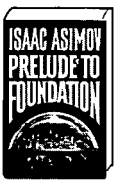

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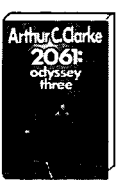

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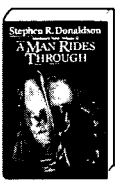

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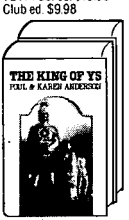

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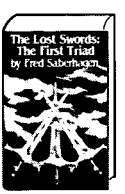

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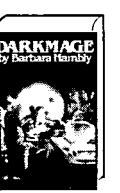

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